

Developing Sustainably and the Emergence of a New Productive Paradigm¹.

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1. Introduction

The advance of human society into the second decade of the twenty-first century of the Common Era (CE) is shadowed by concurrent crises, nascent opportunities and emergent change of epochal magnitude. When viewed within the longer durations of geological time, the human species has undoubtedly achieved significant evolutionary success. Evidence for humanity's success is manifest in its sheer size of population, scale of diffusion across the planet, its collective learning capacities, and adaptive capabilities. The approach adopted in this chapter is to consider the challenges of contemporary development and sustainability from the perspective of economic history. It will utilise the conceptual tools of political economy to discuss the evolution of the contemporary crises confronting human society. In adopting a historically-determined contextualised approach, the chapter pays particular attention to the opportunities for progressive change that emanate from the contradictions constituting the current stage of globalised capitalism.

The global community of countries have as a consequence of the concurrent capitalist crises been forced into policy frameworks that seek economic stimulation, fiscal austerity and environmental sustainability as public outcomes. With respect to the latter mentioned, Ecuador and Bolivia have enacted legislation that grants justiciable rights to nature³. Notwithstanding such valiant efforts, the threat of an impending ecological catastrophe looms large on the horizon. The difficulties of climate change and global warming are further exacerbated by the expansion of socio-economic inequalities and rising political cynicism at the failure of multilateral processes. Economic growth and expansion are seen as the primary mechanism to redress various accumulated developmental deficits.

¹ This chapter is derived from both a Working Paper developed for the International Workshop on 'Bio-civilisation for the Sustainability of Life and the Planet' organised by FNWG & iBase and a Plenary Presentation made to International Seminar on "Innovation Policies and Structural Change in a Context of Growth and Crisis," organised by RedeSist. Both events were held in Rio de Janeiro, Brazil. The comments received on various drafts are very much appreciated. The assistance of Enver Motala in finalising the text is thankfully acknowledged.

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³ These laws were respectively adopted by the people of Ecuador in their 2008 Constitution in the form an article entitled: the 'Rights for Nature,' and as the 'Law of the Rights of Mother Earth' by Bolivia's Plurinational Legislative Assembly in December 2010. The latter establishes seven judicial rights for nature, including the right to: life including the integrity of ecosystems and natural processes, and the necessary conditions for regeneration; biodiversity which should be preserved without genetic modification; water in sufficient quantity and quality to sustain life, protected from pollution; clean air; equilibrium through 'maintaining or restoring the interrelation, interdependence, complementarity, and functionality' of all parts of the Earth; restoration of ecosystems damaged by human activity; and live free of pollution including toxic and radioactive waste.

Amongst progressive political economists, there is widespread convergence of views that the concurrent crises confronting humanity and the planet emanate from the contemporary hegemonic mode of production, distribution and consumption. The origin of these crises can therefore be traced to the global expansion of capitalist relations of production and contradictions arising from the international division of labour. The resulting wastages, environmental degradation and ecological catastrophes have escalated to a scale and scope whereby the continued existence of the human species faces a multiplicity of threats. Earth is in the midst of the sixth mass extinction period: the ‘Anthropocene’ (Zalasiewicz et al: 2008). This recently framed geological epoch acknowledges the devastation that results from the impact human activities on the planet’s ecosystems and biodiversity.

The contemporary crises of global capitalism are, however, only the most acute in the last eighty years of its nearly five centuries of history. The financial component of the crises essentially arose in the most mature of the capitalist economies, the USA and Europe. From such parochial roots, toxic debentures and derivatives have infected the world-system as a whole. This chapter contributes to the debate on sustainable development. It seeks to identify the emergence of a new productive paradigm. This chapter is composed of six sections.

After this first brief introductory section, the chapter proceeds to sketch a succinct history of the contemporary crisis confronting human society. The third section is concerned with the accumulated impacts, generated through the course of human-led development, upon the ecosystem of the planet. The fourth section continues the critique of the current hegemonic development model and highlights the considerable contestation emerging around the conceptualisation of a ‘green economy’. This section questions the capacity for *actually existing capitalism* to embrace the challenges of sustainability and ecological congruence. The fifth section describes the emergence of elements of new productive paradigms. This section thereby seeks to advance the discussion about the emergence of alternatives in production, distribution, consumption and waste-management.

The concluding section draws upon a central challenge articulated by Immanuel Wallerstein who framed the contemporary challenge as “the issue is not what will magically solve the immediate dilemmas of our world-system but the basis on which we shall create the successor world-system” (2005). This chapter therefore proposes an agenda of social inclusiveness, environment stewardship and global cooperation in research and development as the means towards ensuring more progressive outcomes for the planet and its kingdoms of bacteria, protozoa, chromista, plantae, fungi and animalia.

2. Historical Origins of Contemporary Crises

This section of the chapter explores the evolution of human development until the contemporary conjuncture. It is argued that the trajectory of social, economic and political transformation through which the human species has expanded to comprise nearly seven billion people is inextricably enjoined within the dialectic of class struggle and inter-enterprise competition. The theoretical basis for this section draws upon the insights of many progressive political economists. Frederick Engels provides an enduring summary of this line of enquiry when he argued that “(t)he materialist conception of history starts from the proposition that the production of the means to support human life and, next to production, the exchange of things produced, is the basis of all social structure; that in every society that has appeared in history, the manner in which wealth is distributed and society divided into classes or orders is dependent upon what is produced, how it is produced, and how the

products are exchanged. From this point of view, the final causes of all social changes and political revolutions are to be sought, not in men's brains, not in men's better insights into eternal truth and justice, but in changes in the modes of production and exchange" (1892: p. 410).

In this section, it is argued that the spectacular rise of the humanity as the hegemonic species on the planet was achieved through evolutionary adaptation, cooperation, collaboration and competition. The rivalry that generated competition amongst people has impacted upon the production of knowledge. Collectively, however, such competition has ultimately advanced human progress against all other forms of life on Earth. The *détournement* under capitalism of competition defined as the survival of the fittest and the pursuit of unregulated growth has tended to obscure the damages wrought upon the planet.

Earth currently hosts nearly seven billion people organised within approximately 203 geographic political units. Of these, 193 are internationally recognised by other countries as sovereign states in so far as they possess a permanent population, a defined territory, a government and the capacity to enter into relations with the other states. A further 10 territories however lack the unanimous legitimacy accorded by the United Nations including Palestine and the Western Sahara [Sahrawi Democratic Republic]. The current social, political and economic characteristics of humanity are the result of millennia of evolutionary development punctuated by revolutionary transitions which have accelerated transformation.

The composition and geology of the planet and its location in the multiverse has given rise to the emergence of complex ecological systems and biomes that support life. . Scientists have suggested that the planet Earth has a history that began less than five billion years ago. Between then and approximately two billion years ago, the structure of the planet, its size and cosmic coordinates began to be established. The time between the planet's origins and approximately 542 million years ago comprised nearly 90% of its history. In this time, the oceans, atmosphere, and continents formed. Bacteria also emerged; Oxygen levels built-up; and multi-celled organisms began to evolve. The following graphic describes the longer timeframe within which one can understand where we are today.

INSERT FIGURE 1

The human species is currently hegemonic relative to the totality of the planet's inhabitants which are classified into six kingdoms of bacteria, protozoa, chromista, plantae, fungi and animalia. The complex interaction over long periods of time between elemental matter and their organisation into organisms has resulted in the generation of life that is diverse and capable of extensive variations. While the Earth formed some 4.5 billion years ago, our earliest living ancestors only appear in the fossil records of palaeoanthropology approximately 7 million years ago. The genus *Homo* appears only about 2.5 million years ago as defined by increased brain-sizes and tool utilisation as distinctive characteristics of our common ancestry. Skeletons similar to our current form appear in the fossil record approximately 190,000 - 150,000 years ago and are recognised as *Homo sapiens sapiens*.

It is estimated that the total population of the human species around 100,000 BCE was only approximately 20,000 individuals. From a relatively small base, the estimated global population of the human species, grew to half a million in 30,000 BCE and then accelerated within the contemporary geological age. Our current interglacial period, characterised by warmer global average temperatures is dated at about 10,000 years ago and the end of the last

great Ice Age provides a major marker in the history of the human species. It is at that time, approximately 12,000 years ago, that it is speculated that the southern point of South America was reached. Human mobility has generated impacts on all the territories through which the species has travelled.

Humans are the products of biological evolution shaped by geophysical factors just as in the case of all other organisms on the planet. In a broad anthropological sense, human culture has afforded the species the opportunity to transcend the limitations of its biological makeup and access to purely natural resources⁴. The human species is part of nature, and while it represents some evolutionary advantages, it remains capable of behaving in ways that appear to be separate from nature and sometimes even opposed to its own self-interests for survival. Climate change, social organisation and a rapid acceleration in the rate of innovation saw the domestication of plants and animals spread rapidly amongst the human species. Friedrich Engels (1876) and Vere Gordon Childe (1936) have, amongst others, argued that human evolution separated from being but a product of natural selection through the improved learning and communicating capabilities that allowed humanity to generate technological innovations and transmit such ideas across generations. It is generally accepted that contemporary humans can no longer exist purely in natural environments without tools, equipment and techniques of deriving their material base of existence.

The diffusion of technology allowed for more settled populations to become established and changed the social life from subsistence towards surpluses and accumulation. Accompanying this material transformation was the emergence in the division of labour with increasing levels of specialisation and sophistication. It is estimated that cultural differentiation through abstract reasoning dates back to approximately 9,600 BCE and coincides both with the generation of surplus production and with preoccupations concerning authority, ancestry and inheritances. The emergence of social hierarchies and political power was essentially shaped through the harnessing of violence as a mechanism for legitimating possession and dispossession. Foraging was replaced by farming and the technological advances over time provided the platform for social, economic and political adaptation.

More recently, and especially in the last few millennia, the evolution and expansion of the human species has wrought considerable changes to the environment. In their quest for hegemony over the planet, socially dominant classes and groups of society have wreaked havoc in their single-minded pursuit of power and profit ignoring the welfare of the planet. Whilst earlier forms of production may have resulted in human beings erring through naivety and ignorance, the rapid accumulation of knowledge and its universal availability no longer affords any justification for acting in a manner that results in damage to the very mechanisms supportive of life on the planet.

Although advances in science and technology result from the collective inquisitiveness of humanity, the derived benefits remain inequitably distributed amongst all human beings. As a socially evolved subsystem, knowledge is also an expression of the relations of power in society. The effect of these social relations is that global and local inequality is reproduced through oppressive systems that maintain the authority of the few over the majority.

⁴ Pinnacle Point, on the South African coast, shows evidence of habitation from about 160,000 years ago, whilst Blombos Cave, also on the South African coast, has provided evidence of an ochre stick with geometric patterns and is considered the oldest cultural artefact in human history (a work of art in itself, though simultaneously a tool for creating other artwork).

During the preceding three millennia, and most concentrated in the last five decades, environmental degradation, atmospheric emissions and water pollution have accumulated. Thus the planet is now experiencing an acceleration in the mass extinction of biodiversity, global warming and climate change⁵. Exacerbating uncertainty is the recognition that the world's weather patterns have been radically altered making abrupt climate change unpredictable though inevitable. This situation is compounded by the continued extraction of non-renewable resources and the dominance of unsustainable consumption patterns. Together these factors conspire towards defining our current epoch as the Anthropocene. Whilst the exact dating of this geological era remains unclear, consensus is emerging which locates its origins in the Industrial Revolution of the late 18th century CE (Zalasiewicz et al.: 2008, amongst others). This coincides with the establishment of the current capitalist mode of production.

Human society has largely evolved through non-linear phases. Contemporary human society is the collective result of long periods of change. From an early gestation as proto-humans, human society has progressed through stages as hunters, early agriculturalists, advanced agriculturalists and industrialists to the current technological society. Common to all hitherto phases have been the general increased intensity in the utilisation of knowledge. A materialist conception of history suggests a sequencing of successive transitions in human society as advancing through Palaeolithic, Neolithic, Urban and Industrial stages of human cultural and historical development, punctuated by at least three major revolutions.

A Neolithic Revolution transformed hunter-gatherer cultures into settled agriculture. An Urban Revolution transformed Neolithic agriculture which was generally characterised as small, family-based, non-literate agricultural villages into becoming more complex, hierarchical systems of manufacturing and trade. This helped establish human settlements that became large, socially complex, urban societies. An Industrial Revolution massively expanded productive capabilities, increased outputs of commodities and expanded trade on an international scale. All three of these revolutions were rooted in the material base of the societies. These revolutionary changes would however ultimately transform the very forces which had in-deed and in-thought unleashed them. In all instances, new regimes arose from the development of the forces of production embedded with physical and technological resources with major implications for social, economic and political organisation.

The ascendancy of capitalism is premised on the separation between labour and capital. It is a relatively recent development in human evolution. Its deployment and expansion into global relations has revolutionised human life on this planet. The first stage of industrial capitalism is often characterised as a period of liberal (*laissez-faire*) competition. The establishment of the capitalist mode of production proceeded on the brutal separation of people from property. The ensuing relations of production between owners of capital and labour matured over a long period until the end of the 19th century CE. According to Karl Marx (1867), the capitalist mode of production was essentially the process of commodity production whose sole purpose was the accumulation of surplus value. Capitalism can be described as the process of exploiting labour power with the object of accumulating surplus value for the continued reproduction of capital.

⁵ “climate change” means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. (Article 1(2) UN Framework Convention on Climate Change).

David Harvey (1982) recognised that in the circuit of capital described above, the owners of the means of production and labour would ultimately also have to be the potential customers for the products and services created. Within a closed system, the same enterprise would need to generate additional value which would need to be greater than merely the sum of the labour and the capital utilised in the process of production. Such 'additional value' becomes realisable through the establishment of future prices. Ultimately, the actual profit remains the value created in a process of surplus extraction, namely, exploitation. It is against this difference between the full cash value of today's product and future commodity value (that are yet to be produced), that the credit system was established and 'fictitious capital' was created. This fictitious capital represents money brought into circulation as capital without any material basis in commodities or actual 'productive' activity. It is upon this basis that the banking system expanded and eventually would come to occupy such a significant role in contemporary society.

Scholars such as Rudolf Hilferding described the transformation of competitive and pluralistic liberal capitalism into monopolistic 'finance capital' (1910). The unification of industrial, mercantile and banking interests had defused the earlier liberal capitalist demands for the reduction of the economic role of a mercantilist state. Finance capital rather sought a centralised and privilege-dispensing state. According to Hilferding, this changed the demands of capital and of the bourgeoisie from when its initial constitutional demands affected all citizens alike towards now seeking, under the direction of a strengthening finance sector, state intervention on behalf of the wealth-owning classes: capitalists, rather than the nobility of the Feudal and earlier modes of production (ibid.).

This second stage of the capitalist mode of production has variously been identified as a period of monopoly capitalism. Vladimir Ilyich Lenin defined the period of imperialism as the highest stage of capitalism (1916). This stage took root from the beginning of the 20th century and extended well until the early 1970s. Whilst the basic thrust of this stage was expanding capitalist relations of production across the globe, the period also witnessed the unleashing of various strategies including the integration of banks and industry, the export of capital, the exacerbation of inter-imperialist conflict, a reduced life cycle for fixed capital, accelerated technological innovation, permanent military economies, the growth of multinational corporations and the expansion of credit and the resultant global indebtedness.

The requirements of reproducing capitalism now shape and influence the direction of human development. According to Immanuel Wallerstein the driving underlying objective of capitalists in a capitalist system is the endless accumulation of capital, wherever and however this accumulation may be achieved (2011). Since accumulation is however premised upon the appropriation of surplus values, the resulting *immiseration* of the general population and the working class in particular, drives the struggle between classes.

According to an assessment by John Bellamy Foster, Brett Clark, and Richard York (2010), the source of our ecological crisis can be traced to the paradox of wealth in capitalist society, which expands individual riches at the expense of public wealth (including the wealth of nature). Emerging from the process of private accumulation is a huge ecological rift driven between human beings and nature. Foster et al argue that the rift in the metabolic relation between humanity and nature is irreparable within capitalist society. Fundamental changes in social relations must occur if the ecological and social problems currently confronting the planet are to be transcended. Their analysis points importantly towards moving beyond the

current regime of capital, which may be characterised as a form of neo-liberalism, and the necessity of advancing towards a society of sustainable human development.

To advance along such a suggested path it is however necessary to deepen our understanding of this current phase of global capitalism. Neo-liberalism represents a historical process which has systematically sought to dismantle many of the structures that limit and regulate the operation of the market, both with regard to relationships between capital and labour and with regard to relationships between different capitalist enterprises (Harvey: 2005). Neoliberalism is the current hegemonic paradigm of empire and ideological system in the 21st Century. David Harvey has defined the six main characteristics of Neoliberalism as follows:

Firstly, he identified the liberation of enterprises from all regulatory boundaries. These had been previously established by governments, acting as the state, towards the objective of the total freedom of movement for capital, goods and services.

Secondly, public expenditure on social services including health, education and welfare has been significantly reduced. The ideological framing of welfare as a burden on the public fiscal mechanisms has been used to justify this approach which breaches the liberal social contracts of Thomas Hobbes (1651) and John Locke (1689) amongst others.

Thirdly, neoliberalism has sought to reduce the social wage of the poor in society. This has included reductions in fiscal spending and disinvestments from the maintenance of public infrastructures such as shelter, water, transport and other amenities. Running in tandem has been an increasing subsidisation of private enterprise interventions through tax credits, direct transfers of authority and other means which privilege the ruling classes.

Fourthly, another key aspect of neoliberalism has been its focus on extensive deregulation, including dismantling environmental protection, health and safety provisions.

The fifth defining feature of neoliberalism is the selling of state-owned enterprises, goods and services to private investors. This form of privatisation has generally included development finance institutions, capital goods industries, railroads, toll highways, electricity, schools, hospitals and even fresh water. Privatisation has sought to achieve the objectives of increased efficiencies and maximum resource optimisation. The global results however indicate an increased concentration of wealth in a few hands and increases in costs to users of utilities. In some instances, privatisation as an explicit policy is pursued through corporatisation of public entities which provides the cover for private sector behaviour behind the façade of public sector authority.

The sixth main characteristic of neoliberalism is a summative feature through which the very concept of 'public goods' and even the notion of communal solidarity is being replaced by individual responsibility. This has the effect of shifting the blame to victims whilst increasing the alienation of the poor. The elite beneficiaries of neo-liberalism increasingly agglomerate around shared cosmopolitan values and are delinked from and opposed to the real struggles of the marginalised in various underdeveloped territories (Harvey: 2005).

The ultimate consequence of the political economy of global capitalism, its neoliberal ideology and the conflation of multiple crises unleashed is a massive increase in inequality across the wide world and within national political units. This gross effect correlates the growing intra-national and international inequalities. Dissatisfaction, unrest and insecurity are

increasing together with the deployment of state terrorism⁶ as organised violence becomes the only mechanism available to maintain the status quo and ensure its reproduction.

3. Planetary Impacts and Thresholds to Life

This section discusses the impact of contemporary global capitalism on the planet. It is specifically argued that crisis prone capitalism is incapable of meeting the basic needs of food, shelter, health, and education in a sustainable manner. Whilst capitalism has assumed global hegemony, it remains neither homogenous nor lethargic. Rather it is the relentless expansion of capitalism that engenders wanton destruction, increased reliance on organised state violence and welfare to maintain social order, in its quest for perpetual exploitation and expropriation. The escalating voices of the poor in particular, the working class in general and increasingly, elements of the precarious middle-strata are beginning to coalesce in responding to the perpetual demands of capital for expansion. Spontaneous protests, mass organisations and direct action are but some of the means through which the people of the planet are currently engaged with global capitalism.

The idea that the planet Earth is a complex natural system with multiple feedback loops has been well established in the literature. James Lovelock (1979) explicitly argued that all biological organisms and their inorganic surroundings on the planet are closely integrated to form a complex and self-regulating system, maintaining the necessary conditions for life. This concept became popularised as the ‘Gaia Hypothesis.’ When any parts of this system are damaged or altered, it contends, the others respond by attempting to repair, or compensate for, the damage in order to restore the essential balance. Whilst the human species has indeed accumulated considerable competencies through research, science, and technology, our collective global knowledge remains uncertain and incomplete. Humanity still lacks a grand unified theory that captures the totality of the complex systemic underpinning of life on earth and in the wider cosmology.

Arising from such an acknowledgement, the United Nations Conference on Environment and Development of 1992, held in Rio de Janeiro and also known as the Earth Summit, shaped its article 15 as a precautionary principle⁷. Whilst humanity has inordinate power to materially alter planetary realities, its potential remains constrained by the limits of its knowledge, technological capabilities, and competences. Environmental degradation is exacerbated through intensified exploitation and oppression through mass unemployment in the formal sectors, short-term contract work, ‘casualisation’, increasingly meaningless and boring labour punctuated by periods of structural unemployment and short-time work, declining real wages, and a rapidly diminishing social wage. The resulting alienation on a global scale is escalating the instances of mental health problems and crime.

The planet currently faces multiple tipping points that will ultimately signal the failing of some of the world’s ecosystems, with life-threatening consequences for all. According to an international team of scientists examining numerous interdisciplinary studies of physical and biological systems, nine environmental processes were determined that could disrupt the planet’s ability to support human life (Stockholm Resilience Centre, 2009). These include:

⁶ Amnesty International defines organised violence as: arbitrary detention, unfair trial, torture, and political murder or extrajudicial execution.

⁷ In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

stratospheric ozone layer; biodiversity; chemicals dispersion; climate change; ocean acidification; freshwater consumption and the global hydrological cycle; land system change; nitrogen and phosphorus inputs to the biosphere and oceans; and atmospheric aerosol loading.

INSERT FIGURE 2

The boundaries for these processes recognise the limits within which humankind can safely operate and are indicated by the green zone in Figure 2. Seven of these processes have clear boundaries established by science, whilst simultaneously confirming the importance of the principle of uncertainty. Three of those boundaries—for climate change, ocean acidification and stratospheric ozone depletion—represent tipping points, and the other four signify the onset of irreversible degradation. The remaining two processes comprising atmospheric aerosol pollution and global chemical pollution have no determined limits, due to their recent age and lack of long time-series datasets.

As Fred Magdoff and John Foster explain: “(s)taying within each of these boundaries is considered essential to maintaining the relatively benign climate and environmental conditions that have existed during the last 12,000 years (the Holocene epoch)” (2011: page 13). According to scientific evidence currently available, Magdoff and Foster suggest that we have already exceeded three of these: climate change, biodiversity and the nitrogen cycle. A number of others are in danger of being transgressed in the near future: ocean acidification, global freshwater use, change in land use and the phosphorous cycle (Magdoff and Foster: 2011).

Current changes to the climate and potentially irreversible climate change implies the loss of productive land, extreme weather conditions, rising sea waters, massive dislocation of people, desertification and serious economic and social upheaval. Other resource shortages like fresh water, forests, agricultural land, and biodiversity are being severely impacted. Depletion of oil and gas reserves impacts directly on the lives of the billions of people of the world and the fragile biosphere. The current production paradigm remains locked into fossil fuel dependencies that include energy intensive extraction, long distance transportation, and mass-scale production systems. This underlying energy-complex that is linked to a myriad of services and products constitutes an important site of conflict in the face of recognising the planet as a finite eco-system system in itself. The mineral endowments of the planet developed over billions of years yet its rate of extraction has accelerated with the advance of science and technology. The net effect is that the stocks of planetary resources are being depleted faster than nature can replenish them. This is taking place with a seeming indifference to intergenerational concerns.

The scientific consensus is that global warming is largely the result of increased atmospheric concentrations of carbon dioxide and other greenhouse gas emissions. The growth in emissions is caused by human activities, primarily fossil fuel combustion and changes in land use, such as agriculture and deforestation. The Intergovernmental Panel on Climate Change projects an increase of future average global surface temperature in the range of 1.1°C to 6.4°C by 2100. This warming, along with the associated changes in precipitation, drought, heat waves, and sea-level rise, will have important consequences for the ecosystems of the planet, the global political economy, governance and social relations.

Bill McKibben has argued that increased emissions of carbon dioxide and other greenhouse gases into the atmosphere are resulting in damage to the planet's natural climatic systems and other vital ecological assets, including oceans, forests, and glaciers. As these are all components of the planet's integral makeup, the damage being inflicted upon them will trigger defensive feedback mechanisms such as rising temperatures, shifting rainfall patterns, and increased sea levels, among other reactions (2010). In a recent study, Campanale and Legget argue that the world has already by 2011 used over a third of its 50-year carbon budget of 886GtCO₂, leaving 565GtCO₂ (2011). Their research also calculates that the proven reserves owned by private and public companies and governments are equivalent to 2,795 GtCO₂ (ibid.).

Fossil fuel reserves owned by the Top 100⁸ listed coal, oil, and gas companies represent total emissions of 745GtCO₂. This therefore implies that only 20% of the total reserves can be burned unabated, leaving up to 80% of assets technically unburnable. These empirical findings confirm the need for a radical transformation of the energy complex underpinning globalised capitalism. In a similar vein, McKibben has argued that total carbon emissions from all forms of energy use reached 21.2Gt by 1990 (2010). McKibben has projected that emissions would rise ominously to 42.4Gt by 2035 which would represent a 100% increase in less than half a century (ibid.).

Whilst the above cited data only represents a partial coverage of the technical aspects of climate change, it nevertheless points to the dire position of perpetuating the current production paradigm. McKibben argues further that the planet is in currently in a “co-revolutionary” situation (2010). Lenin had defined a classical revolutionary situation as comprising three major symptoms: “(1) when it is impossible for the ruling classes to maintain their rule without any change; when there is a crisis, in one form or another, among the ‘upper classes’, a crisis in the policy of the ruling class, leading to a fissure through which the discontent and indignation of the oppressed classes burst forth. For a revolution to take place, it is usually insufficient for ‘the lower classes not to want’ to live in the old way; it is also necessary that ‘the upper classes should be unable’ to live in the old way; (2) when the suffering and want of the oppressed classes have grown more acute than usual; (3) when, as a consequence of the above causes, there is a considerable increase in the activity of the masses, who uncomplainingly allow themselves to be robbed in ‘peace time’, but, in turbulent times, are drawn both by all the circumstances of the crisis and by the ‘upper classes’ themselves into independent historical action” (1915).

The global response to climate change has reached a critical juncture. The three major symptoms of a revolutionary situation are apparent across the globe though in discrete and sometimes unconnected forms. Linking together the various demands for global equality with the struggle for ecological sustainability provides a major means through which a post-capitalism may be imagined. Progress towards such a unity in praxis remains uneven and largely driven by the agenda's established by multilateral institutions. Since the signing of the United Nations Framework Convention on Climate Change (UNFCCC) in Rio de Janeiro (Earth Summit) in 1992, the countries of the world have attempted to address climate change through increasingly complex large-scale multilateral negotiations. These efforts have produced altogether generated disappointing outcomes. As evidence for the quickening pace of climate change mounts, the treaty-making process has spluttered, and many are now sceptical about the prospect of an effective global response. With the twentieth anniversary of

⁸ Listed on the London Stock Exchange.

the Earth Summit approaching in 2012, the limitations of multilateralism under the fetters of global capitalism are becoming even more evident.

As an alternative pathway towards global consensus on the global ecosystem, the World People's Conference on Climate Change and the Rights of Mother Earth was hosted in Cochabamba in 2009. The declaration of the meeting outlined a comprehensive listing of ten principles for recognising the 'Rights of Mother Earth' framed in the context of understanding that all life, including humanity, only exists within a dialectical and symbiotic relation with the planet. The UNFCCC has failed in its 15th incarnation in Copenhagen in 2009, no final solutions were represented by COP 16 Cancun in 2010 and evidence emerging from the dismal performance of its 17th Conference in Durban in 2011 does not augur well. The ethical and moral principles established in Cochabamba however provide a better context within which the concept of a 'green economy' may be further explored. This would necessarily suggest alternatives in research, development, science, technology and innovation underpinning production, distribution, consumption, and waste management. Sustainable social, economic and political development will become possible if the productive paradigm also transforms.

Whilst no global consensus on appreciating the thresholds of the planet's carrying capacity for life seems evident, the sentiment is increasingly becoming self-evident. The contemporary system of global capitalism enveloping the planet remains marked by distinct patters of combined and uneven development. The resulting inequalities, marginalisation and exclusion require a fundamental reassessment of the current productive paradigm as its trajectory seems irrevocably headed towards an impending ecological catastrophe. Converging global living standards between the more developed with the rapidly developing parts of the world, as exemplified by the rapid catching up of Brazil, Russia, India and China (BRICS) with the Organisation of Economic Cooperation and Development (OECD) further strains the planetary thresholds. Notwithstanding this remarkable transformation of the global division of labour, the vast majority of citizens within the BRICS countries have not experienced the widespread availability of material benefits through improved living standards. Epochal changes are required though such agitation may still be ascribed as demanding the impossible. A 'green economy' may however hold a migratory pathway away from the accumulation trajectory of global capitalism.

4. Critique of Contemporary Capitalism and the contested 'Green Economy'

This section describes emergent alternatives to contemporary global capitalism and is particularly concerned with the conceptualisation of a 'green economy'. Whilst envisioning a post-capitalist future may seem premature in the face of the hegemony of the contemporary neoliberal model of globalisation, the fate of the planet demands that alternatives be considered. As observed by Friedrich Engels: "(t)he extension of the markets cannot keep pace with the extension of production. The collision becomes inevitable, and as this cannot produce any real solution so long as it does not break in pieces the capitalist mode of production, the collisions become periodic. Capitalist production has begotten another 'vicious circle'" (1877).

Confronting the system as a whole has proven incredibly difficult because the complex dynamics between productive sectors, geographic territories and the lack of absolute scientific evidence. Making matters worse for alternatives to emerge are extent of the neoliberal ideological capture of many of the world's governments, persistent corruption and

a 'hollow' state which seems only capable of feeble responses. The consolidation of monopolies, oligopolies and cartels has also served to further weaken the expansion of smaller enterprises and alternative forms of organisation such as cooperatives. Trans-national corporations currently operate on metric scales which are comparable to many countries. According to the TNI, forty-one of the world's largest economies are now corporations (2012).

INSERT TABLE 1

Whilst noting the difference between the value-addition represented by GDP and its difference from revenue-flows, Table 1 shows that largest trans-national corporations predominate in the sectors concerned with automobiles, finances, oil and retail. In fact, eight of the top ten largest global corporations work in the sectors of oil and gas. These collectively suggest a particular bias towards technologies which are based on fossil-fuels.

In a path breaking study conducted for the United Nations Environmental Programme (UNEP), it was calculated that the estimated annual environmental costs from global human activity is the equivalent of 11% of global GDP (2011c). It was further estimated that the cost of environmental damage caused by the world's 3,000 largest publicly-listed companies represented only 7% of their annual revenue's or US\$ 2.15 Trillion (ibid). It is important to note that the largest corporations may not be in any significant hurry to make a transition towards sustainability, as such investment decisions would tend to erode their current global rankings. However, most of the private sectors under global capitalism occupy their positions in a temporal fix. They are therefore neither permanent nor omnipotent. Understanding the dynamics of change has been the research focus of numerous scholars over time. Studying the variations in business over longer time scales has earned it the title of Long Waves. The Russian Marxist economist Nikolai Kondratieff is recognised as having established the broad theoretical school in the 1920's. Kondratieff's main research line was concerned with the study of all types of business cycles in the capitalist economies.

INSERT FIGURE 3

According to Goldstein, the original work of Kondratieff gave rise to particular school of long waves which he characterises as being concerned with Capital Investment (1988). For this approach to long waves, "long waves arise from the massive investment in, and depreciation of, such long-lived capital goods as railroads, canals, and factories. During an economic upswing, overinvestment in capital goods occurs; this causes a downswing in which excess capital is depreciated. The depreciation of capital on the downswing opens the way for a new period of massive investment, again overshooting as the upswing continues. Key variables are capital investment and production" (Goldstein: 1988: Page 24). In response to the work of Kondratieff, Leon Trotsky adopted a more radical line of enquiry and has come to epitomise a Capitalist Crisis school in the 1920s.

INSERT FIGURE 4

The Capitalist Crisis School approach viewed long waves as recurring major crises in capitalism that arise from the tendency of the rate of profit to decline. According to Goldstein: "(t)he recovery from such crises is not endogenous to the capitalist economy, but results from exogenous factors (such as imperial expansion, the discovery of new natural resources, or the suppression of labour movements) that intervene to restore favourable long-

term conditions of accumulation. The rate of profit increases, allowing a new upswing but the next crisis follows inevitably. Key variables are the profit rate, class struggle, and production” (ibid.). Within such a construction, the outcome of a crisis is not predetermined but depends on class struggle and concrete historical conditions.

While Goldstein distinguishes between at least four varieties of long wave theoretical schools, our concern in this chapter remains with matters of crisis and innovation. Goldstein identifies a third approach that is further developed by Joseph Alois Schumpeter and may be caricatured as an innovation approach. In this framing, “long waves arise from clusters of innovations at particular times and in particular economic sectors. These clusters of related innovations create a new ‘leading sector’ of the economy that grows rapidly and drives a general economic upswing. While that upswing continues, radical innovations are discouraged since existing investments in existing technologies are bringing good returns. However, the initial innovations eventually bring diminishing returns, and the economy slows down and slides into a downswing. The downswing encourages innovations, but there is a time lag before these can be developed. Key variables are inventions and innovations, production, and employment” (1988: Page 24). Advancing upon this work is the critical scholarly work of Chris Freeman and Carlota Perez which have come to be recognised as Techno-Economic Paradigms (TEP).

INSERT FIGURE 5

Perez has established that technical change occurs by revolutions in market economies. According to Perez, capitalism has experienced pendulum swings every two or three decades which link from the Installation Period led by finance, with unfettered free markets to force the propagation of the technological revolution through to a Deployment Period led by production aided by government to fully spread the new potential across the economy and its benefits across society. A major financial crash marks the swing of the pendulum. According to Perez, “The world is currently going through the turning point. The future is now being defined globally and in each country” (2011).

According to Rajesh Tandon, the “technological advancements of the last two to three centuries have created a sense of instrumentality among the scientifically trained among us; this instrumental rationality drives our perpetual efforts at controlling, manipulating and redesigning our natural environment to fulfil human needs, and ambitions” (2011). Tandon argues for a fundamental recognition that “technology needs to serve the larger public good for humanity, rather than merely advancing production and consumption” (op cite). Tandon positions the challenge of sustaining the human spirit at the heart of sustainability of humanity and planet earth, and therefore warns that this can be achieved only if moral and ethical considerations underpin the future design of the economy and community (ibid).

Multiple expressions currently co-exist and suggest an alternative path of development for the planet. These include, amongst others, green growth, green stimulus, green technologies, green sectors, green business and green jobs. The idea of a ‘green economy’ generally emphasises environmental sustainability and protection while pursuing sustainable development. Martin Khor has recently argued that the ‘green economy’ is “an extremely complex concept and it is unlikely there can be a consensus on its meaning, use and usefulness and policy implications, in a short time” (2011). He however acknowledges that a ‘green economy’ “gives the impression of an economy that is environmentally-friendly, sensitive to the need to conserve natural resources, minimise pollution and emissions that

damage the environment in the production process, and produces products and services the existence and consumption of which do not harm the environment” (op cite).

UNEP has proposed that a ‘green economy’ would generate improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (2010). They therefore define the ‘green economy’ as being characterised by being low carbon, resource efficient and socially inclusive (ibid). On a practice note, UNEP has maintained that a ‘green economy’ also implies that “growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services” (ibid). These investments need to be catalysed and supported by targeted public expenditure, policy reforms and regulation changes. This development path should maintain, enhance and, where necessary, rebuild natural capital as a critical economic asset and source of public benefits, especially for poor people whose livelihoods and security depend strongly on nature.

The ‘green economy’ must therefore be built upon the foundations of a decaying and crisis prone global capitalism. It will necessarily involve global coordination and planning but should not reproduce the failures of centralised commandist planning. Equality and redress must also accompany the liberation of enterprises and households from behaviours that seek short-term ‘profits’ at the expense of medium- and longer-term sustainability.

A further point requiring further discussion is the notion of freeing time towards increased leisure and voluntarism. Building international cooperation and solidarity requires an increased intercourse between the peoples of the planet, the environment and the systems of production, distribution, consumption and waste management. Early critiques of political economy from the time of the establishment of industrial capitalism until the current conjuncture have not resolved the wage-slavery and class struggles that drive accumulation trajectories. The ‘green economy’ requires ‘green jobs’ within ‘green enterprises’ under participative and democratic regimes of governance. Introducing such progressive ambitions into global capitalism may not however be possible. Similarly, calls for a further reduction of the ‘work-week’ in absolute time as a means towards expanding employment opportunities and reducing the stress load on current workers may also be difficult to negotiate. The seeming inability of global capitalism to absorb such reforms further strengthens the need for a deeper engagement with progressive social, political and economic forces. The prospects of constructing the ‘green economy’ within of the parameters framed by global capitalism remain a daunting challenge and may actually constitute a divergence from the important tasks of building a post-capitalist future.

An approach which recognises the variations that constitute global capitalism also makes possible the vision of the ‘green economy.’ Such a perspective appreciates that the centuries of accumulated uneven and combined development has indeed shaped a massively unequal and differentiated community of political units. The process of globalisation has accelerated the integration of markets and finances. It has largely ignored the contradictory effects on human mobility and social cohesion. For a ‘green economy’ to transcend the boundaries of the current epoch, it will be necessary to increase efforts at building international cooperation and solidarity. Intra-national and regional efforts at integration should also be fostered and encouraged. Shifting the scope of attention from the current 193 UN-recognised political units (countries) towards biomes and ecological regions could offer humanity and the planet a better basis for global planning and coordination.

Such a transition also requires the halting of the unregulated tyranny of capitalist competition in matters concerned with production, distribution and consumption. The establishment of a post-capitalist mode of production urgently requires a global compact that is both socially legitimate and politically empowered. The global compact would also need to establish mechanisms to ensure that the expansion of productive activities is reconciled with ecological constraints. In responding to another major division in the productive capabilities, the global compact approach could also be mandated to advance the critically important tasks of improving the knowledge-base of humanity as a whole and the planet in common. Building such a global knowledge commons may indeed prove to offer the opportunity of a 'quick win'. The main reason for such optimism is the very fact that the people and institutions in the science and technology sector are also those who are at the research frontier and are therefore encountering information that suggests the impending catastrophe of anthropocene.

Ugo Pagano has advocated the need for a 'new global Keynesianism' (2008). According to Pagano, anti-crisis policies should include the funding of public research infrastructures. His argument has four main criteria. These are enumerated below:

1) The funding does not involve a nationalisation of the firm or the use of taxpayers' money without any counterpart. By contrast, while the IPR is paid at its private value, it is transferred in the public arena where it has a greater public good value and decreases costs for many producers.

2) Financial support is granted to firms who have proved to be innovative. A powerful stimulus for new investments is given to the most efficient firms. On the one hand, these firms receive fresh funds but, on the other hand, having sold the old intellectual property rights, they face tough competition. Therefore, they have an urgency to invest in the production of new intellectual assets, which boosts aggregate demand.

3) A monopoly price for the asset is replaced by the lower competitive price, which has a positive effect on aggregate demand.

4) The "anti-commons" problem is eased; everyone can now invest in new knowledge with the awareness that complementary pre-existing knowledge is less likely to be owned by other firms. The policy decreases the costs of future risky transactions necessary to use the fruits of innovation. While immediate funding goes to incumbent innovative firms, which may often belong to richer countries, the increase of the knowledge freely available to everyone has widespread beneficial effects and contributes to the overall development of the world economy (Pagano: 2008).

Whilst such a reformist agenda should necessarily include huge cutbacks in the arms industry, the provision of free public transport and downgrading of private transport, the lowering of dependence on fossil fuels, and the ending of the media and advertising industry's promotion of a consumerist philosophies with their monumentally wasteful production of superfluous commodities are often touted as routes towards global salvation, they remain unattainable under capitalist relations of production. It may even be suggested that capitalism currently threatens the very life of the planet.

Capitalism has created the conditions of current over-production and under-consumption through its relentless and ultimately self-destructive drive for profit. Improvements in the material living conditions of humanity have resulted from the extension of the provision of

various infrastructures including water supply, housing, electricity, transport connections and a wide range of essential products and cultural activities. This is however not universalised and has increasingly become dependent on international linkages in global chains of production for their provision and maintenance. The costs with respect to these infrastructures are being disproportionately borne by the working class and those entering the margins of the middle strata.

UNEP believes that a ‘green economy’ will be the result of two major factors. Their analysis points to the need to increase investments in the sustainability of ecosystem services upon which much of the world’s poor depend, and thereby ensure that the environment can continue to be used for the benefit of current and future generations. They also argue that strategies for economic growth on the sustainable use of natural resources and the environment must generate long-term jobs and wealth as a means towards eradicating poverty (2011). These sentiments are indeed laudable and should be supported. We should recognise that ‘trickle-down’ approaches adopted post the second world war have all tended to expand rather than redress inequality, worsen poverty and increase marginalisation. The successes of the last sixty years have largely been the result of continuous struggles that have culminated in the Nordic model of welfare producing better social results than the other variants of capitalism.

5. Elements of a New Productive Paradigm

The concern over social and environmental sustainability is definitely opening new windows of opportunity for the emergence of a new productive paradigm. As has been discussed hitherto, the support for promoting a new trajectory for humanity is premised on both a critique of actually existing capitalism and the rapid accumulation of science and technology capabilities counter-posed to the current over-dependence on fossil fuels. This affords to countries, sectors and enterprises the chance to accelerate and accumulate their consolidation strengths. The public sector would assist by supporting enabling legislative environment to redress weaknesses in systems. An associated public sector function would be to mitigate threats through facilitating the achievement of socio-economic consensus and ensuring broad sectoral participation. It may thus be argued that the types of innovation policies required to strengthen the low-carbon technological trajectory include elements that enable socio-economic and political consensus and essentially seek to expand local productive competences; build local resilience and adaptive capabilities; and enable participation in framing global research

Whilst it is undoubted that human ingenuity has underpinned technological progress, the transformation of scientific insights into innovation has indeed been restricted by the needs of capital accumulation. The key technological trends that have been consolidating are mainly derived from Biomedicine; Computing; Energy generation, storage and transmission; Genomics; Information and communication technologies; Nanotechnology; Quantum physics; and Synthetic biology. These new technologies are largely emerging from convergence processes where different technological systems have rapidly evolved towards the performance of similar tasks. The evolution of these relatively new fields have also benefited from the exponential progress achieved in basic sciences, expansion of international collaboration and the demands for public good research outcomes.

The linkage between science and technology and innovation is through the productive sector (both public and private). Thus the opportunities through which the benefits of the rapid

expansion of science and technology capabilities may be realised are through enterprise development and growth. The main vehicle for a virtuous correspondence between the producers of knowledge and the users of science and technology is through the deployment of conventional industrial support tools. These include revitalising the processes of reskilling and retooling enterprises. Explicit support of an expansion of employment tied to regulatory enforcement of localisation in sourcing would also facilitate innovation-enabled development which delivers employment and other developmental outcomes.

Currently, new industrial sectors are emerging in the more advanced productive systems and include classifications such as the clean economy industry categories and segments developed by Brookings-Battelle primarily for the USA. Whilst such transitions are afoot, other less encumbered territories, such as Brazil, South Africa, India and China, are expanding their productive systems and infrastructures towards an orientation that is ostensibly linked to sustainability. Thus, China has recently emerged as the country with the highest public market financing in the clean energy sector. While the USA was ranked first in terms of its total clean energy investment in 2008, by 2010 it had been overtaken by both China and Germany. China has also been able to secure more than twice the asset financing (US\$ 47.3 Billion) for clean energy projects in 2010 than the USA's US\$ 21 Billion (Third Way: 2011).

With such massive changes in resource mobilisation, it is not surprising that Chinese companies represented nearly 60% of all clean energy technology initial public offering (IPOs) in the world in 2010 (ibid.). According to Ernst and Young⁹, China has replaced the USA in terms of its attractiveness for renewable energy investments and received nearly 20% of total global clean energy investment in 2010. The ability of China to attract US\$ 54.4 Billion in clean energy financing in 2010 represented a 39% increase over 2009 and was equal to the entire amount of clean energy investment worldwide in 2004 (Third Way: 2011).

The spectacular performance of China is sufficient evidence that changing pathways and breaking with dependencies are indeed possible. Tools of innovation policies that support and promote a socially inclusive technological trajectory should include explicit planning, regulation, monitoring, evaluating and learning functions. It is also important to escalate work directed at facilitating equality and sustainable development outcomes whilst supporting and consolidating the capabilities to generate public goods in science and technology. Developing countries would also specifically need to advance anti-hegemonic geo-political coalitions and alliances, lest they tend towards merely reproducing the current status quo.

6. Conclusions

The specific objective conditions that underpin the current phase of global capitalism demand the emergence of collectively determined responses that seek to build global solutions, international cooperation, and solidarity. Thus whilst the creation of a new unified and planned global community seems the logical response in the face of mounting environmental degradation, most policy developments remain premised on building local resilience against impending ecosystem catastrophes. Progressive organisations involved in the struggle for social justice and the individuals involved in these struggles have the role of uniting autonomous organisations around a clear vision of a future global community, which can

⁹ Ernst & Young (2011) Renewable Energy Country Attractiveness Indices, Issue 31 [November].

develop out of the conditions and the struggles of today and which would be imbued with the transcendental objective of building post-capitalism.

Internationalising research and development will help build capabilities across territories of the world. Already, excellent examples of such efforts are being realised through scientists and engineers 'without borders'. Such progressive collaborations also advance the possibilities of developing a global planning regime with the authority and legitimacy to control the proliferation of environmentally detrimental activities whilst incentivising positive change. Unfortunately, none of these progressive outcomes are plausible within an academic field/domain subjugated to the fundamental orthodoxy of neo-classical economics, dominated by the financial/fictional fraction of capital and buttressed by the might of neoliberal ideologies. To allow the human species to survive, thrive and build the progressive 'green economy,' requires that heterodox perspectives occupy a central space in reshaping academia. Shaping theory from facts must drive new enquiry and contribute to a renaissance in the discipline of economics

Whilst it is undeniable that a 'green economy' is necessary to overcome the effects of poverty and the unfair global distribution of wealth, its conceptual framing and policy implications requires utmost vigilance. The world of the 21st Century is the result of evolutionary social, economic and political developments and transitions sometimes accelerated by revolutionary transformations. The power of rapid and profound change has however lagged behind the more incremental adjustments that have largely come to characterise contemporary global capitalism. This characteristic of social, political and economic change is not new as the contradictions of past systems always mature before they give birth for the conditions for their end. The very future of the planet, bacteria, protozoa, chromista, plantae, fungi and animalia will largely be determined in the current choices being made by the current generation of the human species. For the 'green economy' to grow and transcend the failures of global capitalism, humanity and the planet demand a new evolutionary political economy to guide such a revolutionary transformation.

7. Bibliography

- Bourguignon, François (2011) *A Turning Point in Global Inequality ... and Beyond*, OECD, Paris.
- Campanale, Mark and Jeremy Leggett (2011) *Unburnable Carbon – Are the World's Financial Markets Carrying a Carbon Bubble?* Carbon Tracker Initiative, London. Accessed at: www.carbontracker.org.
- Childe, Vere Gordon (1936) *Man Makes Himself*, Coronet Books, Philadelphia, [2003].
- Engels, Friedrich (1876) *The Part played by Labour in the Transition from Ape to Man*, Progress Publishers, Moscow [1934].
- Engels, Friedrich (1877) *Anti-Dühring: Herr Eugen Dühring's Revolution in Science*, Progress Publishers, Moscow [1978].
- Engels, Friedrich (1892) *Socialism: Utopian and Scientific*, in *Marx Engels Selected Works* Progress Publishers, Moscow [1986].
- Ernst & Young (2011) *Renewable Energy Country Attractiveness Indices*, Issue 31 [November].
- Goldstein, Joshua S. (1988) *Long Cycles: Prosperity and War in the Modern Age*, Yale University Press, New Haven.
- Harvey, David (1982) *The Limits to Capital*, Blackwell, Oxford.
- Harvey, David (2005) *A Brief History of Neoliberalism*, Oxford University Press, Oxford.
- Khor, Martin (2011) *The "Green Economy" Debate: A Sustainability Perspective*, Alainet.org. Accessed at: http://www.forumdesalternatives.org/EN/print.php?type=A&item_id=9546.
- Kleinknecht, Alfred, Ernest Mandel, and Immanuel Wallerstein (1992) *New Findings in Long Wave Research*, St. Martin's Press, New York.
- Lenin, Vladimir Ilyich (1915) *The Collapse of the Second International*, in *Lenin Collected Works: Volume 21*, Progress Publishers, Moscow, [1974].

- Lenin, Vladimir Ilyich (1916) *Imperialism, the Highest Stage of Capitalism*, in *Selected Works*, Progress Publishers, Moscow, [1963].
- Lovelock, James (1979) *Gaia: A New Look at Life on Earth*, Oxford University Press, Oxford.
- Magdoff, Fred and John Bellamy Foster (2011) *What Every Environmentalist Needs to Know about Capitalism: A Citizen's Guide to Capitalism and the Environment*, Monthly Review Press, New York.
- Maharajh, Rasigan (2011) *The Green Economy, Poverty and the Global Inequality*, Working Paper of the International Workshop on Biocivilization for the Sustainability of Life and the Planet, FNWG & iBase, Rio de Janeiro.
- Mandel, Ernest (1980) *The Long Waves of Capitalist Development*, University Press, Cambridge.
- Marx, Karl (1845) *The German Ideology*, in *Marx-Engels Collected Works*, Volume 5, Progress Publishers, Moscow, [1932].
- Marx, Karl (1867) *Capital: Criticism of the Political Economy*, Volume 1, Progress Publishers, Moscow, [1984].
- McKibben, Bill (2010) *Eaarth: Making a Life on a Tough New Planet*, Macmillan, New York.
- O'Hara, Phillip Anthony (2006) *Growth and Development in the Global Political Economy: Social Structures of Accumulation and Modes of Regulation*, Routledge, Oxford.
- Ocampo, José Antonio (2011) *The Transition to a Green Economy: Benefits, Challenges and Risks from a Sustainable Development Perspective: Summary of Background Papers*, Report by a Panel of Experts to the Second Preparatory Committee Meeting for United Nations Conference on Sustainable Development, New York.
- Pagano, Ugo (2008) *Anti-crisis Policies in Knowledge Intensive Economies*. Accessed at: www.feed-charity.org/user/image/pagano2008a.pdf.
- Perez, Carlota (2002) *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*, Edward Elgar, Cheltenham.
- Perez, Carlota (2011) *Technology, Growth and Jobs after the Crash*, Global Policy Forum, Yaroslavl [September].
- RMI (2011) *Reinventing Fire: Blueprint for a new Energy Future*, Rocky Mountain Institute, Boulder.
- Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber, B. Nykvist, C. A. De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley (2009) *Planetary Boundaries: Exploring the Safe Operating Space for Humanity*, *Ecology and Society*, 14 (2). Accessed at <http://www.ecologyandsociety.org/vol14/iss2/art32/>.
- Singh, Pritam (2007) *Poverty, Global Inequality and Sustainability: A Critical Evaluation of Marxist and Green Perspectives*, Global Poverty Research Group and Brooks World Poverty Institute Conference, Manchester, July.
- Tandon, Rajesh (2011) *Sustaining the Spirit: A Challenge to Humanity*, in *Development*, 54 (2), pp. 197–198.
- TNI (2012) *Planet Earth: A Corporate World*, Infographic, TransNational Institute. Accessed at: <http://www.tni.org/report/state-corporate-power-2012>.
- Trotsky, Leon (1923) *The Curve of Capitalist Development*, in *Fourth International*, 2 (4), May, pp. 111-114, [1941].
- UK Parliament (2010) *Low Carbon Technologies in a Green Economy*, Fourth Report of Session 2009–10, Volume 1, Energy and Climate Change Committee, House of Commons, The Stationery Office Limited, London.
- UN (2011) *World Economic and Social Survey 2011: The Great Green Technological Transformation*, Department of Economic and Social Affairs, United Nations, New York.
- UNEP (2009) *Global Green New Deal: Policy Brief*, United Nations Environment Programme, Nairobi.
- UNEP (2011a) *Decoupling Natural Resource Use and Environmental Impacts from Economic Growth*, United Nations Environment Programme, Nairobi.
- UNEP (2011b) *Global Trends in Renewable Energy Investment 2011: Analysis of Trends and Issues in the Financing of Renewable Energy*, United Nations Environment Programme and Bloomberg New Energy Finance, Frankfurt.
- UNEP (2011c) *Universal Ownership: Why environmental externalities matter to institutional investors, Principles for Responsible Investments and United Nations Environment Programme Finance Initiative*, London.
- Wallerstein, Immanuel (2005) *After Developmentalism and Globalization, What?* in *Social Forces*, 83(3), March.
- Wallerstein, Immanuel (2011) *Structural Crisis in the World-System: Where Do We Go from Here*, *Monthly Review*, 62 (10).
- WWF (2011) *The Energy Report: 100% Renewable Energy by 2050*, World Wide Fund for Nature, Gland.

Zalasiewicz, Jan Mark Williams; Alan Smith; Tiffany L. Barry; Angela L. Coe; Paul R. Bown; Patrick J. Brenchley; David Cantrill; Andrew Gale; Philip Gibbard; F. John Gregory; Mark W. Hounslow; Andrew C. Kerr; Paul Pearson; Robert Knox; John Powell; Colin Waters; John Marshall; Michael Oates; Peter Rawson; and Philip Stone (2008) Are We Now Living in the Anthropocene? In *GSA Today*, 18 (2), pp. 4-8.

FIGURE 1

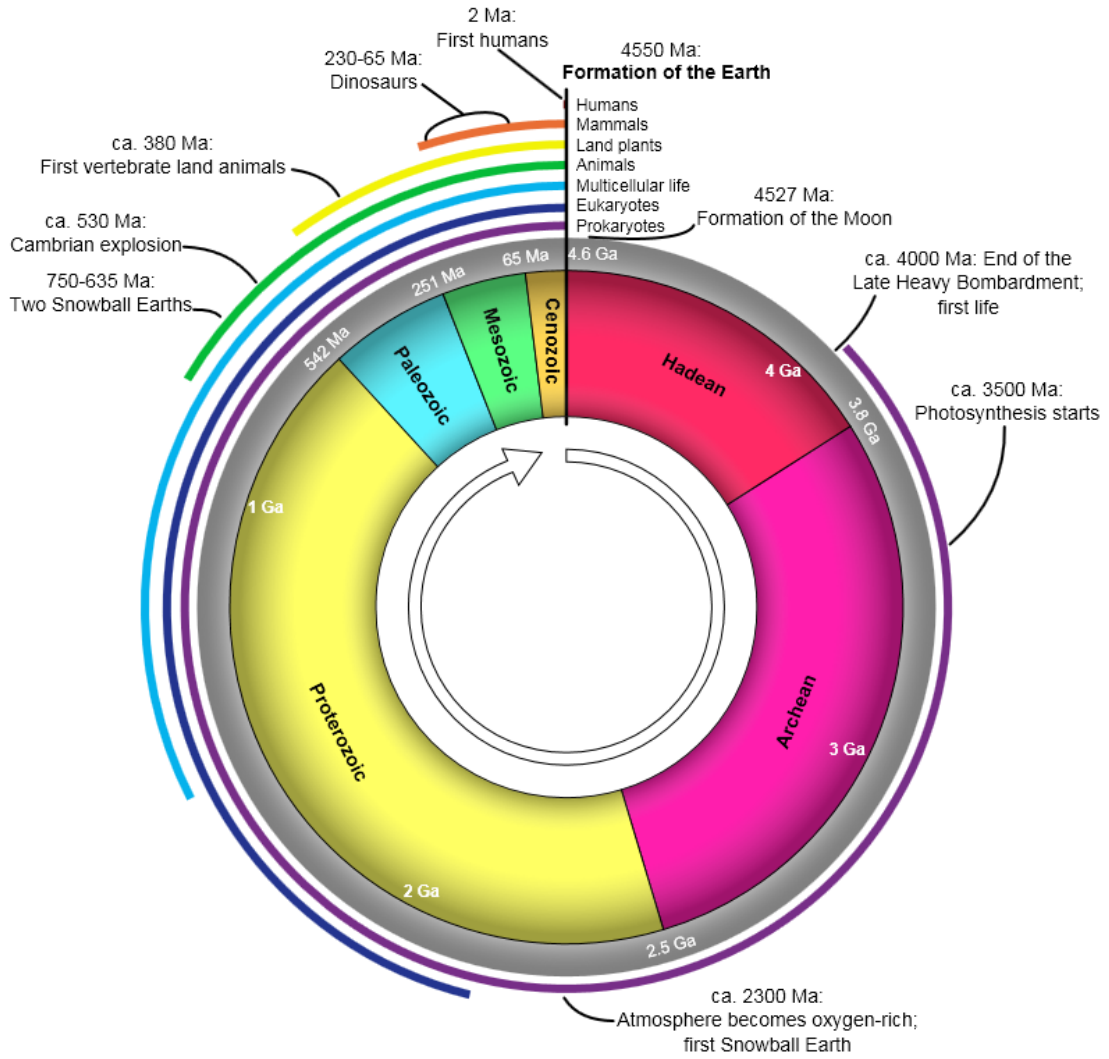


FIGURE 2

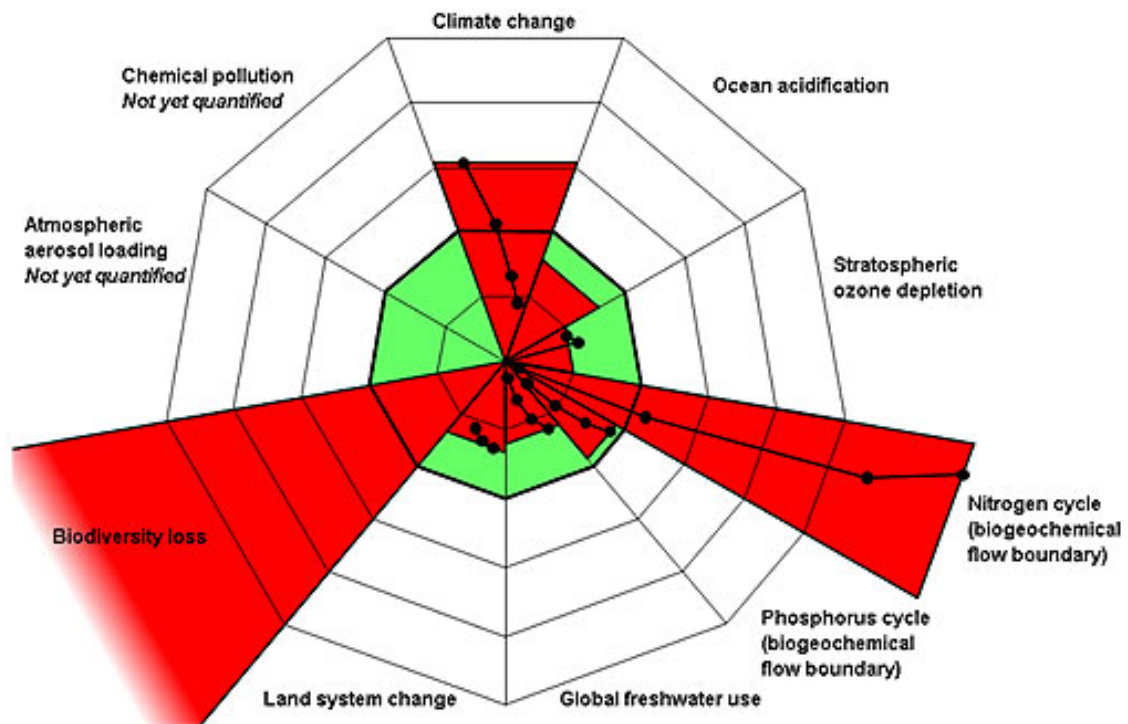


FIGURE 3

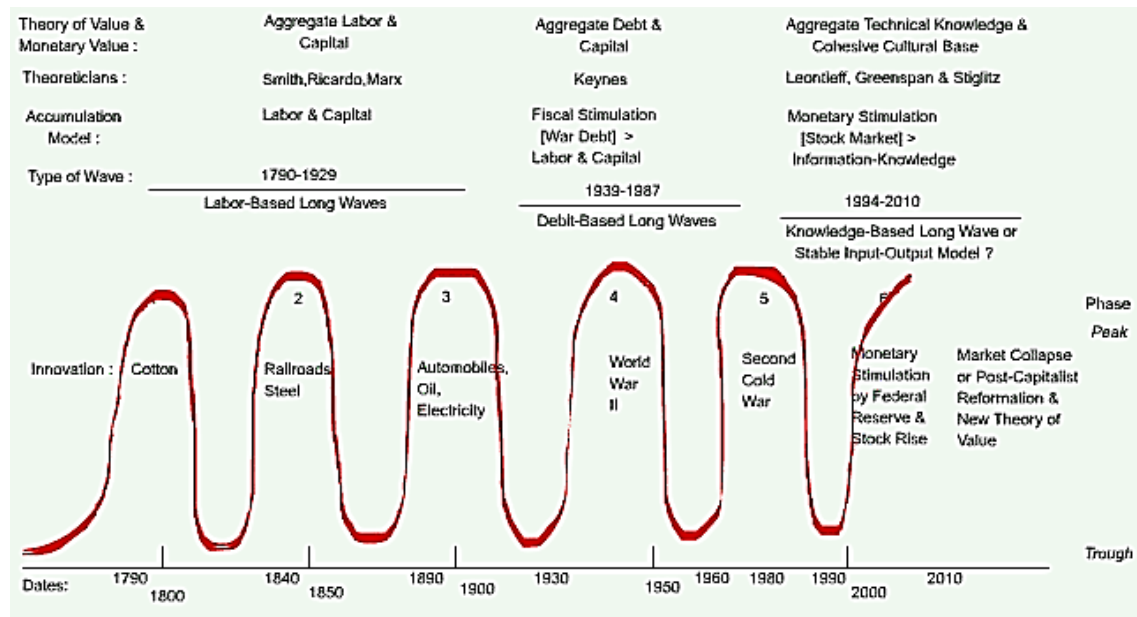
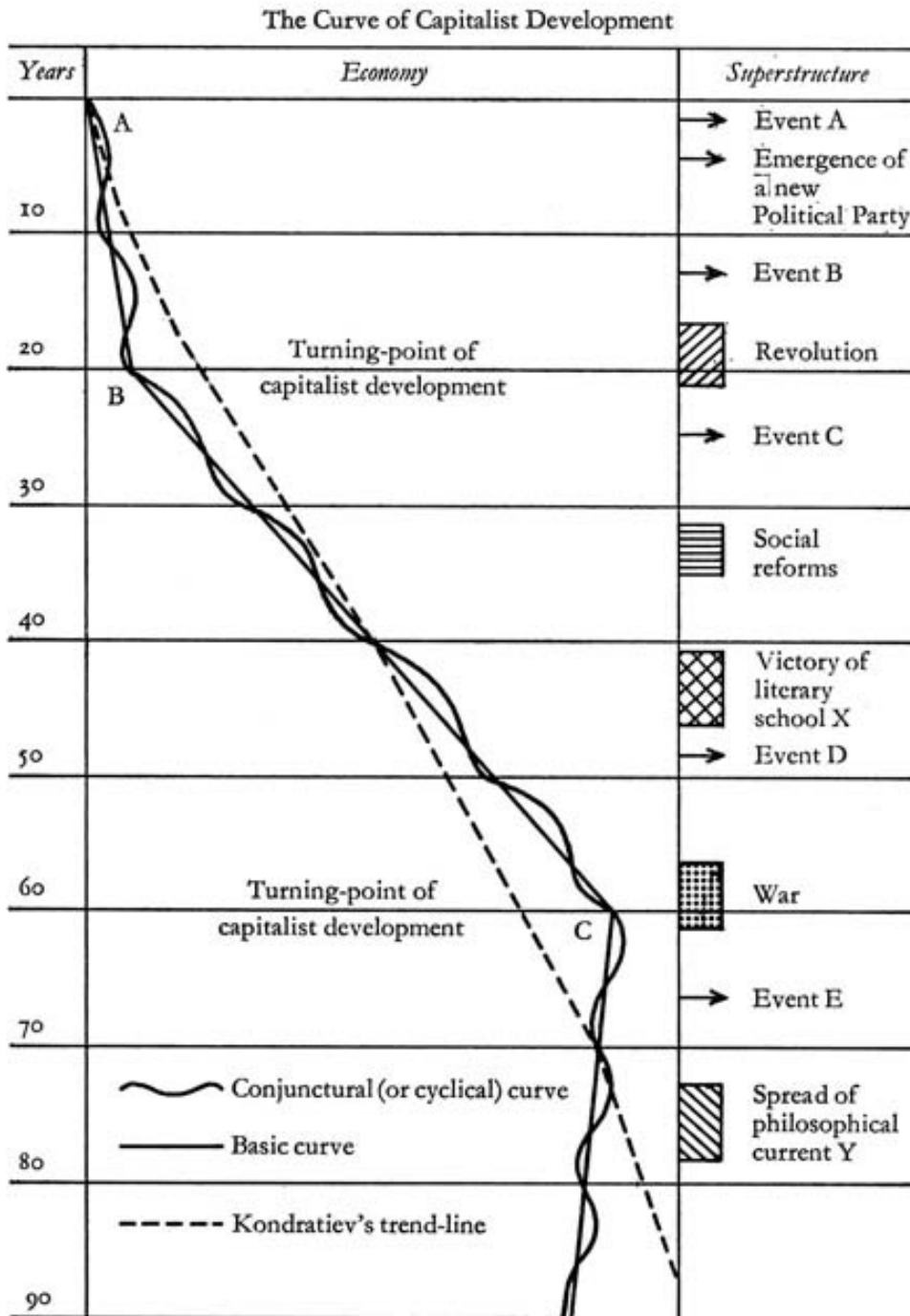
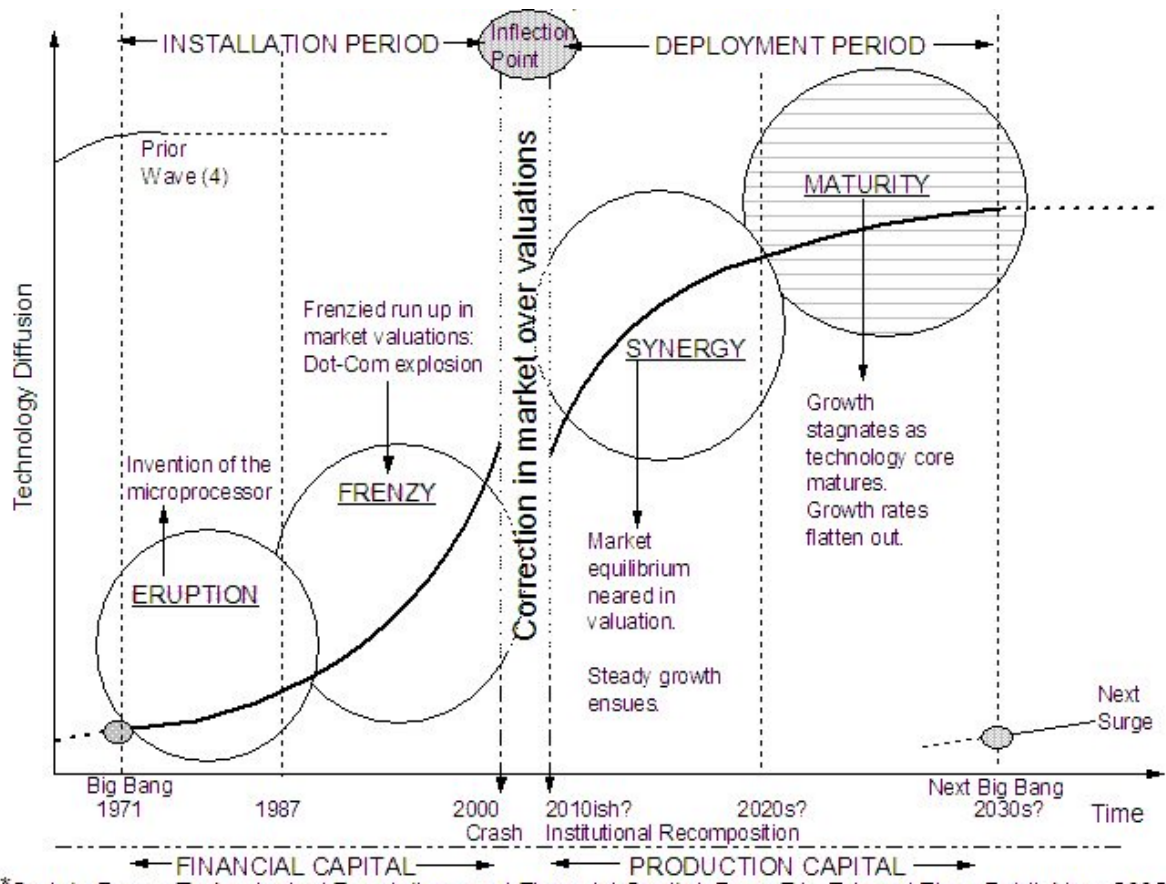


FIGURE 4



SOURCE: L. D. Trotsky, 'O krivoi kapitalisticheskovo razvitya', in *Vestnik Sotsialisticheskoi Akademii*, No. 4, April-July 1923.

FIGURE 5



*Carlot Perez Technological Revolutions and Financial Capital Page 74 Edward Elgar Publishing 2002

TABLE 1

Table 1. World's Largest Economies based on 2010 GDP or Revenues in US\$ Billions		
<i>Rank Order</i>	<i>Country</i>	<i>Corporation</i>
1	USA	
2	China	
3	Japan	
4	Germany	
5	France	
6	United Kingdom	
7	Brazil	
8	Italy	
9	India	
10	Canada	
11	Russia	
12	Spain	
13	Australia	
14	Mexico	
15	Korea	
16	Netherlands	
17	Turkey	
18	Indonesia	
19	Switzerland	
20	Poland	
21	Belgium	
22	Sweden	
23	Saudi Arabia	
24	Taiwan	
25		Wal-Mart Stores
26	Norway	
27	Iran	
28		Royal Dutch Shell
29	Austria	
30	Argentina	
31	South Africa	
32		Exxon Mobil
33	Thailand	
34	Denmark	
35		BP
36	Greece	
37	United Arab Emirates	
38	Venezuela	
39	Colombia	
40		Sinopec Group
41		PetroChina
42	Finland	
43	Malaysia	
44	Portugal	
45		State Grid
46	Hong Kong SAR	
47	Singapore	
48		Toyota Motor
49	Egypt	
50	Israel	
51	Ireland	
52		Japan Post Holdings
53	Nigeria	
54	Chile	
55	Philippines	
56		Chevron
57	Czech Republic	
58		Total
59		ConocoPhillips
60	Pakistan	
61		Volkswagen
62		AXA Group

63	Romania	
64	Algeria	
65	Peru	
66		Fannie Mae
67		General Electric
68	Kazakhstan	
69		ING Group
70		Glencore International
71	New Zealand	
72	Ukraine	
73		Berkshire Hathaway
74		General Motors
75		Bank of America
76		Samsung Electronics
77	Kuwait	
78		ENI
79	Hungary	
80		Daimler
81		Ford Motor
82		BNP Paribas
83		Allianz
84	Qatar	
85		Hewlett-Packard
86		E.ON
87		AT&T
88		Nippon Telegraph & Telephone
89		Carrefour
90		Assicurazioni Generali
91		Petrobras
92		Gazprom
93		J.P. Morgan Chase & Co.
94		McKesson
95		GDF Suez
96		Citigroup
97		Hitachi
98		Verizon Communications
99		Nestlé
100		Crédit Agricole
101		American International Group
102		Honda Motor
103		HSBC Holdings
104		Siemens
105		Nissan Motor
106		Pemex
107		Panasonic
108		Banco Santander
109		IBM
Source: TNI, 2012.		