

Chapter 6

The circular economy: A critique of the concept

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Abstract

The circular economy is an increasingly influential school of sustainable economic thinking, dominating recent five-year plans in Chinese policy while also featuring regularly in the sustainability discourse in the European Union and beyond. It is often said that the history of a concept tells us more about it than does the concept itself, and so we begin by contextualizing the circular economy through its historical development. We then compare and contrast the two dominant geo-political versions of the circular economy, the Chinese model and the Western (European) model, identifying differences and issues in underlying principles. Particular attention is paid to the impact of populist economics and the COVID-19 pandemic. The Dual Circulation Strategy of the 14th Five Year Plan is then examined. In order to explore the current and future prospects for the circular economy, we explore the Earth system, on which, ultimately, our species relies upon. By teasing apart its functionality, two levels of organization emerge: local and global. The chapter ends with an exploration of what this means for any concept of sustainable economics and concludes by identifying the key characteristics of such a concept.

Keywords: Chinese economic policy, Dual circulation strategy, Earth system, European economic policy, Indigenous economics

Introduction

The circular economy is an increasingly influential school of sustainable economic thinking, dominating recent five-year plans in Chinese policy while increasingly featuring in the sustainability policies of the European Union. It is a contested concept, with questions surrounding its theoretical and practical feasibility (Korhonen et al., 2018; Skene, 2018; Millar et al., 2019). Furthermore, recent developments in Eastern and Western interpretations and applications differ significantly. This all leads to confusion in terms of any global conversation and in terms of delivering a sustainable transition that is so urgently needed. Furthermore, questions about whether it should be a global development or a myriad of small, local circles are being asked (Prendeville et al., 2017; Real et al., 2020). Currently, the global economy is only nine percent circular (with Europe twelve percent and China two percent), and the linear model is still systemically “baked in” (Circle Economy, 2019).

Over one hundred different definitions of the circular economy were identified in a review by Kirchherr et al. (2017). In this chapter, we adopt the definition of Murray et al. (2017), which defines the circular economy as “an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being.”

We begin by contextualizing the circular economy through its historical development, since the history of a concept often tells us as much about it as does the concept itself. We then compare and contrast the two dominant geo-political versions of the circular economy, the Chinese model and the Western model, identifying differences and issues in underlying principles. In order to explore the current and future prospects for the circular economy, we explore the Earth system, on which, ultimately, our species relies upon. By teasing apart its functionality, two levels of organization emerge: local and global. The chapter ends with an exploration of what this means for any concept of sustainable economics and concludes by identifying the essential key characteristics of such a concept.

6.1 Origins and context

Desrochers (2002, 2008) pointed out that concepts such as re-use, recycling and resource and habitat management have played important roles throughout the history of manufacturing. The circular economy was a recognized concept in meaning if not in name two millennia in the past. Back then, rather than environmental damage, it was resource scarcity that drove the pursuit of reduction, re-use and recycling of resources (the 3R concept).

Such approaches also reflected a much more localist approach in terms of short supply chains. Short supply chains bring with them responsibility, accountability and transparency. If you chop the local apple tree down for wood, there will be no more apples. Thus, Hardin’s (1968) Tragedy of the Commons is rarely if ever seen where short supply chains exist and where a functional society operates. This is particularly relevant to first Nations people. For example, the Ogiek people of the Mao forests in Kenya need agreement from the council of elders before cutting down even one tree (Skene, 2019). All this has been lost as we externalize our supply chains, which disappear across the horizons to distant lands, where the true impact is not felt by the consumer halfway around the world.

Figure 1 lays out the conceptual development of the circular economy in terms of its more recent, post-linear economy evolution. As can be seen, many of the major schools of sustainable economics share much in common, and the circular economy is merely a re-expression of concepts that have been around for many years. What is of more interest is how it is interpreted in different nations and trading blocs. We will take two examples, China and the European Union.

6.2 The circular economy in China

Given that the population of China represents around 19% of the global population and given its important position in trade and raw material supply, particularly in terms of the rare earth metal and graphite, the economic practices of China are of vital interest to the rest of the globe. The history of the adaptation of the circular economy as a central theme in policy in China dates back to 1973, when the first National Environmental Protection Conference formulated environmental protection policies and guidelines (Zhang & Wen, 2008). In 1983, the second National Environmental Protection Conference was held, making environmental protection a core national policy. In 1989, the Environmental Protection Law of the People's Republic of China was enacted.

In 2002, the 16th National Congress of the Communist Party of China set out an ambitious development plan involving social equality, the recovery and protection of the integrity of the environment and quadrupling of GDP. This was to be called a circular economy underpinned by a cleaner production strategy. The circular economy is defined in legislation as a generic term for reducing, reusing and recycling activities conducted in the process of production, circulation and consumption. What is interesting about these three goals is that they embrace the three pillars of sustainability: economics, society and the environment. Thus, the Chinese model formally attempted to address all three pillars of sustainability, unlike most of the other schools of sustainability at the time. Three new laws were introduced to move the agenda forward:

- The Cleaner Production Promotion Law (passed on June 29th, 2002 and put into effect on 1st January, 2003)
- The Law of the People's Republic of China on Appraising Environmental Impacts (passed on October 28, 2002 and put into effect on September 1, 2003)
- The Law on Pollution Prevention and Control of Solid Waste (April 2005)

Planning for societal development in China targeted the realization of a healthy, equitable and functional society by the year 2020. These laws appear to be the first in the world to make the circular economy a national strategy of economic and social development. The Ministry of Environmental Protection initiated eco-industrial parks (EIPs) as early as 2002, releasing an EIP standard. Currently, fifty such parks exist.

Guiyang was chosen as the pilot city for implementing a circular economy. In 2004, the Guiyang Circular Economy Development Plan focused on six sectors: coal, phosphorus, aluminium, herbal medicine, tourism and organic agriculture. The law of the People's Republic of China on Renewable Energy was enacted in January, 2006, marking an important step in terms of sustainable energy production. This was followed by the Energy Conservation Law of the People's Republic of China, enacted in January, 2008.

6.3 Five-year plans

The five-year plans, focusing on social and economic development, lie at the heart of policy in China. Beginning in 1953, under Mao Zedong, they were inspired by the soviet model of economic and industrial development.

11th Five Year Plan (2006-2010)

The incorporation of a circular economy into the Outline of the 11th Five-Year Plan for National Economic and Social Development meant increased support and focus on sustainability (Wu et al., 2014). The plan was based on the 3-2-1 model (Tan, 2008) which refers to three industrial systems (the eco-industrial system, the eco-agricultural system and the eco-service system), two domains (production and consumption) and one industrial chain of renewable resources. The Law for the Promotion of the Circular Economy which came into effect on 1st January 2009, promoted resource utilization efficiency, natural environment protection and sustainable development. It operated at 3 levels: individual firms (focused on eco-design and cleaner production), eco-industrial parks (utilizing the waste-is-food concept) and the eco-city and eco-province level (creating a recycling society).

Key objectives were:

- Close monitoring of energy consumption and pollution emissions in heavy industries by government.
- Promotion of recycling, energy efficiency and waste-reutilization standards by government departments and policy development aimed at diversion of capital into environment friendly industries.
- Introduction of water-saving technologies in new buildings and projects.
- Switch from oil-fired fuel generators and boilers to alternative green energy fuels in power generation, steel and iron production plants.
- Adoption of renewable technologies, such as solar and geothermal approaches, to be used by enterprises and government departments in new buildings.
- Recycling and reuse of coal ash, coal mine waste and other waste materials.
- Recycling of straw, livestock waste and farming by-products to produce methane.

As of 2011, tax incentives were expanded, including variable rates of VAT on specific products. Construction materials made from construction waste became VAT-exempt, recycled graphite now could claim a 50% VAT refund and, more eclectically, wigs made from human hair would now earn an 80% VAT refund (Skene & Murray, 2017).

12th Five Year Plan (2011-2015)

In the 12th Five-Year Plan (2011–15), Chapter 22 is dedicated to the circular economy (Mathews & Tan, 2016). Policy shifted from resource efficiency of heavy industries to remanufacturing and recycling of metals and minerals, focusing upon the exchange of materials between companies (Preston, 2012). China's 12th Five Year Plan dedicated huge resources (around US\$ 470 billion) towards the implementation of a circular economy. The development of the Internet of Things to track the resource history of products was implemented as was research into a green economic growth strategy.

13th Five Year Plan (2016-2020)

In the 43rd Chapter of the 13th Five-Year Plan (2016–2020), the importance of CE both as a national policy and as a fundamental pillar of the Chinese economy is clearly stated (Central Committee of the Communist Part of China, 2016, p. 219). It was recognized that a market-based approach could encourage Chinese businesses to pursue a more sustainable path, rather than using incentives such as tax rebates, which did not always provide the expected outcomes (Zhang, 2013).

14th Five Year Plan (2021-2026)

In the most recent Five-Year Plan, in order to boost domestic spending, the Chinese government has set out its so-called Dual Circulation Strategy (DCS). The main idea behind this strategy is to strengthen China's vast domestic market (domestic circulation), while balancing its foreign trade (external circulation). This is a significant change in policy, which had previously focused on export-oriented development since the launch of Deng Xiaoping's reforming policies of 1978.

The DCS represents a new development pattern where domestic and foreign markets can boost each other, with the domestic market as the mainstay. Supply chain issues now take central stage in terms of sources and sinks. By localizing, there is less uncertainty, and less externalization. The "dual-circulation" strategy aims to avoid asynchrony between cycles and feedback loops and government policies by applying flexible, adaptive, institutional and structural approaches.

China's 14th Five Year Plan sets technological autonomy as one of the country's top priorities and signals a shift from pure economic growth to social and climate-friendly development. It is hoped that a new urbanisation strategy, more equal distribution of public goods and increased investment in environmental technologies will deliver new sources for sustainable growth, by improving economic efficiency and by increasing domestic demand (Yang, 2020). It is also envisioned that an increasingly inward, domestic focus of the DCS will protect China in extreme scenarios (such as global pandemics) while reducing China's vulnerability in trade war scenarios (such as with the Trump administration). It is not only the market that is shifting internally. Made in China 2025 (MIC25) aims to achieve independence from foreign suppliers (Liu, 2016). This is important in terms of domestic cycling and supply chain integrity.

China has developed a system of indicators to provide feedback on progress in the circular economy, based around resource output, resource consumption, integrated resource utilization and waste disposal/pollution emission (Geng et al., 2012). Macro-level indicators are used to analyse progress at the national and regional levels, guiding development and planning, while meso-level indicators operate at the eco-industrial park level. Eco-city indicators cover such aspects as local ecosystem value, land greening rate and biodiversity. Finally, CO₂ indicators provides feedback on climate mitigation policies.

6.3 Issues with the Dual Circulation Strategy

Some issues arise from the DCS. The re-orientation of the economy towards a domestic market creates many challenges. For Chinese consumption to be equivalent to that of other developing economies, ordinary households would need to recover at least 10-15 percentage points of GDP at the expense of businesses, the wealthy, or the government (Pettis, 2020). This would

require a massive shift of wealth and power to ordinary people. The success of China's international circulation has been built on low material and labour costs. An interesting point to note here is that with advancing robotic manufacturing, the cost of production, in terms of labour, will soon decrease as a consequence of the loss of human workforce. This is seen to impact the manufacturing geography, making it cheaper to bring manufacturing back to Europe and the USA as transport costs would now dominate over labour costs (Skene, 2019). Thus, a decreased reliance on international markets may well become a necessity anyhow.

The aim of zero net carbon by 2060 becomes more problematic when viewed alongside the DCS, as domestic economic growth will pose huge challenges in terms of the green growth strategy as initially outlined in the 12th Five Year Plan. Furthermore, fundamental issues relate to the core nature of manufacturing in China, which still revolves around a coal-based energy sector, a heavy chemical industry-centred industrial structure and a heavily road-based transportation structure. Li et al. (2020) point to the challenges of urban-rural development, whereby the desire is to move more of the population into cities, raising issues in terms of energy intensity and green agriculture.

Economic growth coinciding with absolute reductions in resource use and emissions is called 'absolute decoupling', while economic growth increasing less than resource use and emissions is referred to as 'relative decoupling' (Skene & Murray, 2017). Whether green growth is even possible, through either absolute or relative decoupling, is highly questionable (Albert, 2020; Hickel & Kallis, 2020). Haberl et al. (2020), having assessed over 800 studies, reported that few delivered absolute decoupling. Ward et al. (2016) report that there is little evidence that GDP growth can be decoupled in the long-term.

6.4 The European approach

While China has led the way in terms of adopting a circular economy, Europe had originally been world leaders, with eco-industrial parks such as Kalundborg in Denmark established in the early 1970s and Germany's recycling laws providing important inspiration in China. However more recently, the EU has fallen behind in terms of national policy. This is understandable, as the EU is made up of 27 nations, with qualified majority voting but, for a number of key issues, unanimity is required. Each of these nations pursues quite different political and economic agendas, while often coming from very different historical contexts. There are large differences between individual nations within the EU, both in terms of industrial profile and pollution production. Some nations are fundamentally agrarian, others industrial, while yet others are firmly in the Information Age. Poverty levels vary widely. All of this heterogeneity provides a massive challenge for the EU, as exemplified by the difficulties in approving the EU budget for 2021-2027, or the membership of North Macedonia.

The origins of a circular economy strategy in Europe can be traced back to 1972. With global environmental awareness growing, the European Commission chairperson, Sicco Mansholt, stated that new economic thinking was needed, based around preventing resource waste, increasing product lifetimes and reducing resource use per capita (Vonkeman, 1996). As early as 1975, a European Communities Council directive emphasised taking "appropriate steps to encourage the prevention, recycling and processing of waste, the extraction of raw materials and possibly energy therefrom and any other process for the re-use of waste" (European Communities, 1975, p. 40).

Since the 1970s, the approach of the EU has been criticised as resembling an incremental policy layering of closed loop thinking rather than some form of paradigm-shifting transformative thinking (Fitch-Roy et al., 2020).

Finally, on December 17th, 2012, The EU released the following statement: “In a world with growing pressures on resources and the environment, the EU has no choice but to go for the transition to a resource-efficient and ultimately regenerative circular economy” (EU, 2012).

They identified 6 action points (EU, 2012):

1. “Encouraging innovation and accelerating public and private investment in resource-efficient technologies, systems and skills, also in SMEs, through a dynamic and predictable political, economic and regulatory framework, a supportive financial system and sustainable growth enhancing resource-efficient priorities in public expenditure and procurement.
2. Implementing, using and adopting smart regulation, standards and codes of conduct that a) create a level playing-field, b) reward front-runners and c) accelerate the transition, and d) consider the social and international implications of our actions.
3. Abolishing environmentally harmful subsidies and tax-breaks that waste public money on obsolete practices, taking care to address affordability for people whose incomes are hardest-pressed. Shifting the tax burden away from jobs to encourage resource-efficiency and using taxes and charges to stimulate innovation and development of a job-rich, socially cohesive, resource-efficient and climate-resilient economy.
4. Creating better market conditions for products and services that have lower impacts across their life cycles, and that are durable, repairable and recyclable, progressively taking the worst performing products off the market; inspiring sustainable life-styles by informing and incentivising consumers, using the latest insights into behavioural economics and information technology, and encouraging sustainable sourcing, new business models and the use of waste as raw materials.
5. Integrating current and future resource scarcities and vulnerabilities more coherently into wider policy areas, at national, European and global level, such as in the fields of transport, food, water and construction.
6. Providing clear signals to all economic actors by adopting policy goals to achieve a resource-efficient economy and society by 2020, setting targets that give a clear direction and indicators to measure progress relating to the use of land, material, water and greenhouse gas emissions, as well as biodiversity. Such indicators must go beyond conventional measures of economic activity, help guide the decisions of all actors, and assist public authorities in timely action. All organisations above a meaningful size and impact must be held accountable to measure and report key non-financial progress indicators on a comparable basis.”

By 2015, the circular economy had become a foundational concept in Europe, exemplified by the report ‘Closing the Loop – an EU Action Plan for the Circular Economy’ (European Commission, 2015), and is now recognized by the European Union (EU) as an “irreversible,

global mega trend” (COM, 2019a, p10). It is a key component of the European Green Deal and the Coronavirus Recovery Plan of the Von der Leyen Commission (2019-present) (European Commission, 2020). Hill (2015) provides an excellent review of the emergence of circular economic concepts within the European Union.

It is clear that the EU views the circular economy as an economic tool, primarily. The idea of green growth and the decoupling of economic growth from environmental degradation pervade, which is quite a reversal from the Environmental Kuznets curve that underpins much of sustainable development thinking and espouses that economic growth will deliver environmental sustainability and equity over time (see Stern, 2004). Yet the Kuznets Curve is acknowledged, in terms of economic growth delivering social justice, when the Council of members write “member states will work towards ensuring inclusive and sustainable growth in the EU, a necessary condition to reduce inequality” (COM, 2019b, p.96). Thus, there is a tension here. As Friant (2020) observes: “By focusing on growth and competitiveness rather than human well-being and ecosystem health, the EU might be creating new business opportunities from some, while doing little towards addressing the core socio-ecological challenges of the 21st century.”

The EU has also set out a clear program for auditing the costs of pollution, a key externality related to market failure, as identified early in the twentieth century by Pigou (1920). To do this they set up ExternE, which concentrates on damage from energy and transport sectors upon the environment. Such audits are seen as essential if a circular economy is to be assessed and implemented in Europe and are based around material flow accounting (MFA) (Bringezu, 2001). The European Environment Agency’s reports include assessments of policy progress and an analysis of key material flow trends.

In 2013, the European Union (EU) Environment Commissioner, Janez Potocnik, set out a parallel path with China, undoubtedly with the hope of encouraging trading relations with China through a shared sustainability approach: “When I look to China's 12th five-year plan and compare it with the EU's political documents, I see a lot of similarities ... It is a really good basis for cooperation” (Potocnik, 2013); however, clear differences exist between the approaches in Europe and in China. While China set out their principles to guide government and in order to communicate the rationale and implementation of their programme to its citizens as *ipsum factum*, setting up new EIP projects continuously and funding from central funds, Europe relies much more on the private sector who they must convince of the merit of such a thing.

The private sector is predominately profit-driven. Hence the emphasis on the financial benefits of the circular economy lies at the heart of European approaches. Western governments are also elected, and so attractive political references relating to jobs, standard of living and the environment play well on national and European stages. Europe also faces the difficulty of significant differences between its member states. One common facet between Europe and China is the dependency on external sources for much of their material and energy needs. However, China’s new DCS points to a separation of pathways here also.

6.5 Indigenous economics

While the Western economic model, founded on neo-liberalism, globalization and a production/service dichotomy (where developing nations produce goods while developed

nations buy and service these products) dominates global trade, a very different approach also exists, modelled on localism, post-development and indigenous thinking. Here, many of the principles of the circular economy have been practiced for millennia, explaining why such approaches have underpinned the long-term survival of ancient people in even the harshest of landscapes. Indeed, the location of many indigenous civilizations today are largely limited to the regions of the planet that are not inhabited by industrialized populations, such as tundra, semi-arid plains and high-altitude environments. The Ogiek people of the Mau forests in Kenya have, for centuries, embraced most of the principles of the sustainable development goals, with the exceptions of goals 8 (Economic Growth), 9 (Industry, Innovation and Infrastructure) and 11 (Sustainable cities) (Njeru, 2018; Skene, 2019).

However, the foundations of these important practices have not emerged from economic theory, nor is the emphasis on green growth and development targets. Rather, these principles emerge from a holistic approach, wherein humans are bound within their social and environmental contexts. The 'more-than-human' relational self lies at the heart of this (Gould et al., 2019), wherein society recognizes the Earth system as the unit of sustainability, with all players as components of that system, contributing to its resilience and functionality.

Many argue that unless we recognise the Earth system as the alpha and omega of our existence, within which we find our evolutionary, ecological, social, economic and individual context and meaning, then we cannot possibly hope for a sustainable future. While the Earth system will continue with or without us, until the Sun eventually expands and consumes it, we, as all species before us, face extinction at some point or another. How we interact with the Earth system is key, and since economics governs the intensiveness of our exploitation of the Earth's resources, the flow of energy through ecosystems (due to fertilizer application) and the sink issues in terms of waste, then contextualizing our economic activity within the Earth system in such a way as to reduce our footprint to an appropriate size must surely be the priority.

In many ways, the Chinese policy of DCS can be seen as an attempt to embrace the benefits of this localized indigenous approach. By developing the domestic economy, China hopes to be less impacted by issues elsewhere on the planet, be they political or pandemic in nature. Ironically, the Trump administration also emphasised a version of this, in terms of nationalism first, internationalism second, creating one of the issues that encouraged the development of the DCS in China, where self-sufficiency and domestic production and consumption can shield from shocks while raising living standards within the nation through increased employment.

However, problems arise in terms of how to implement the vast changes needed. In a low wage structure such as China, increased spending power requires increased wages, increased wages require increased business profitability and increased profitability requires increased consumer spending. This represents a very different form of circular economics. Meanwhile in any given Western nation, production at home costs much more than production in a developing nation, requiring a sharp increase in prices, and further wage increases simultaneously, thus driving up inflation. You can make your own cake and eat it, but you have to pay a lot more for it. Fundamentally, globalized economics still dominates and our supply chains are deeply embedded within this approach. Thus, any attempt to change direction brings with it huge challenges.

However larger challenges exist, in terms of the environmental crisis, impacting such necessities as food production, water supplies, climate and health. The planetary card trumps any economic card and therefore we must shape our economies to support the Earth system if we are to continue as a species.

6.6 The Earth system

In terms of the local/global balance we can learn much from the Earth system. Firstly, the business of the planet is partitioned into biomes, determined by temperature and precipitation. The main biomes, moving from the equator towards either pole, are tropical rain forest, tropical dry forest, tropical savanna, desert, temperate grassland, temperate woodland and shrubland, temperate forest, boreal forest, and tundra. Each of these has evolved over time, with species adapted to the conditions and natural economies matched to these conditions. These biomes, differing in soils, topography and climate, have shaped the ecology and evolution of life within them. A tropical rainforest functions completely differently than an area of tundra, and a desert consists of very different organisms than does a temperate rainforest. For millennia, human cultures have also differed across these landscapes, adapting to the local conditions and resonating with the functioning of these landscapes.

6.7 Local and global realities

Indigenous people living in these biomes, whether it is the Ogiek in the tropical dry forests, the Sami in the boreal and tundra or the Masai in the savanna, each have economies and cultures adapted to their ecological settings. While trade between tribes from different biomes does occur (e.g. honey and milk traded between the Ogiek and Masai for example (Njeru, 2018)), for the most part these tribes have localized economies. Supply chains are short and immediate while accountability is high. Cutting down a fruit tree for fuel is a strategy of doubtful value and would have immediate effects on the local community.

Thus, the idea of local solutions for local communities is an ancient and emergent concept within the Earth system. Furthermore, a rainforest does not strive to convert a desert or a savanna into a rainforest. Each biome functions in the most appropriate way relative to the biogeochemical context within which it finds itself. In other words, the concept of development is not found within the Earth system. However, global issues do exist, in terms of atmospheric gas levels, ocean and air circulation (such as El Nino and El Nina) and long term glacial (Milankovitch) cycles, driven by changes in orbits of both the Earth and the Sun. These impact on most if not all parts of the planet. Indigenous human populations have both globalized and local identities. Thus, we would suggest that a sustainable future requires some sort of balance, but to identify what this should be, we need to further reflect of the origins of global issues within the Earth system.

Localism, in terms of ecology, is easily accounted for, reflecting the tight relationship between any given organism and the biome level differences in climate, biogeochemistry and topography. However global issues, such as the albedo effect, ocean and atmospheric circulation, tectonic plate movements, atmospheric chemistry and long-term cycles in solar radiation (leading to intermittent ice ages), impact across the planet. Anthropogenic impacts can affect both local and global ecology. Global patterns, particularly across human cultures, are emergent yet shared across the world, be it the Inuit and Sami of the Arctic, the Pila Nguru of the deserts of Western Australia or the Pumé people of the Venezuelan savanna. Common

themes include equitable societies, based on indigenous communism and the gift economy, where resources are shared. Furthermore, activity (economics) is firmly rooted within societal and environmental contexts. The tragedy of the commons (Hardin, 1968) is not an issue here, because accountability is a survival skill, not an option.

It has been proposed that the study of local, place-based socio-ecological research allows an insight into the interplay between global and local scales (Norström et al., 2017). Transformations towards sustainability are often triggered at the local scale. It has been suggested that regions may form a useful go-between, connecting the local with the global (Paasi, 2003; Jonas, 2012). Resilience stems from local biocultural diversity, where indigenous knowledge plays an important role, in resonance with landscape (Ruiz-Mallén & Corbera, 2013). Resilience is a system level property, and cannot be built or constructed, but emerges in a functioning ecosystem. However, with 7.5 billion people currently on the planet, dematerializing and localizing the supply chains, reducing waste to appropriate levels, economic degrowth and environmental revitalization pose untrivial challenges. Fundamental to all of this is accountability, wherein our individual decision-making is well informed in terms of its environmental and social consequences. By thinking global and acting local, we do not merely focus on our spatial localities, but rather consider all of the planet as our locality, while preventing environmental and social damage wherever our supply chains lead.

Shortening supply chains brings transparency, accountability and awareness. It also brings resilience, resistance and security against the winds that blow elsewhere. Circularity is much easier if you can actually see the perimeter of the circle. Global supply chains disappear into the mist and are anything but transparent. An example would be the horrific child labour in the mines of the Democratic Republic of the Congo (DRC), with children as young as six years of age forced to work at gunpoint or drugged, underpinning the supply of 50% of the world's cobalt, which plays a key role in electric vehicle batteries (ILO, 2017; Cheruga et al., 2020).

Surely a consumer in Europe who is considering buying a car with cobalt from DRC, must be given the information that allows them to decide if they wish to contribute to the maltreatment of these children? Because whether they know or not, their consumer decision is contributing to this cruel form of slave labour. Consumer awareness will prevent us from facilitating such cruelty.

Artificial intelligence and the internet of things can provide the feedback and information on our supply chains, the impacts on human and ecological communities across the globe and allow us to act for the global good while in our localities (Skene, 2019). The indigenous people who live within these biomes have cultures, economies and behaviour tightly tied to their specific habitats, but also share common global narratives, even though they may never have met. We may have lost much of the ecological intelligence of indigenous people, but our decision-making can still be informed, allowing us to make the decisions that can provide the basis for a sustainable future, one informed decision at a time. Given the advanced technologies now available to us, where remote sensing satellites such as Copernicus can monitor the heartbeat of the Earth system from space, collecting data on every facet of the functioning biosphere, we have unequalled access to the health of our planet and the consequences of our actions.

Conclusions

We have seen that China and Europe have pursued the principles of the circular economy as mainstays of policy for much of the 21st Century. However significant differences exist, both in terms of the political contexts and more recent policy agendas. The DCS has been announced as the next significant development in economic thinking in China, where the domestic economy, in terms of supply chains, production and consumption, will be promoted, thus building resilience, mostly through a decreasing dependence on international markets, which pose increasing risks. A similar, nation-centric approach has recently been promoted by the Trump administration in the USA. Both of these strategies pose significant problems and require significant economic growth. How this fit in with a sustainable transition is less than clear. While these approaches, and the policies of Agenda 30 for sustainable development all embrace economic growth, it is unclear how the planet can heal and where any form of circular economy can persist, given the elephant of problematic supply chains tied up and gagged out-of-site in the cupboard across the corridor and the discordant harmony of economic growth, environmental damage and social inequality.

Recent upheavals, including the interruption of international trade caused by COVID-19 and the rise of populist politics with concomitant nationalism, are likely to drive nations further towards domestic and regional production and consumption, further undermining a globalized economy. This offers opportunities as well as challenges, in terms of a more localized approach to sustainability and to economics. So, what type of sustainable economic strategy should we practice in order to fulfil our objective of continuing to exist, where existence must be within the Earth system, which provides our sustenance, fresh air, water and context? We would suggest that the following characteristics should define any systems-based pathway:

- a. Complementarity, wherein our activities contribute to the functioning of the Earth system, allowing it to repair itself and self-organize;
- b. Resonance, wherein the temporal and spatial patterns of our activities are in tune with the Earth system, both in terms of material and waste cycling, renewable resource use and appropriate, landscape-sensitive care of the commons. Resonance also informs decision-making;
- c. Feedback, where we are monitoring our impact, in real time, and adjusting it where necessary, thus being alive to the emergent and non-linear nature of the Earth system, while understanding our impact upon it;
- d. Sub-optimality, where we optimise for the Earth system while sacrificing our own excesses, and where trade-offs are central to planning, design and lifestyles, rather than problems that need to be overcome.

When these key characteristics can describe our social and environmental interactions, then the path to sustainable economics will reveal itself, most likely at a local level, but governed by global, Earth-system thinking. Predominant across almost all of our time on Earth as a species, is the socio-ecological relationship, rather than the socio-economic relationship. Economics emerges from the former relationship, at a fundamentally local level. Universal to this approach is systems theory, wherein the individual is embedded within a social construct and the social construct is embedded within its broader ecology, embracing ecological ethics. Here context is everything, and all elements within a given landscape are, in a sense, 'globalized', circular, resonant and accountable.

Acknowledgements

I am extremely grateful to Dr Aldo Alvarez-Risco for the invitation to contribute to this volume.

References

- Albert, M.J. (2020). The dangers of decoupling: earth system crisis and the ‘fourth industrial revolution.’ *Global Policy*, 11, 245–254. <https://doi.org/10.1111/1758-5899.12791>.
- Allenby, B.R. (1991). Design for Environment: a tool whose time has come. *Journal of Social Sciences & Arts*, September, 1991, 5-10.
- Benyus, J.M. (1997). *Biomimicry: innovations inspired by nature*. William Morrow.
- Bringezu, S. (2001). Material flow analysis – unveiling the physical basis of economies. In P. Bartelmus (Ed.), *Unveiling wealth* (pp 109-134). Kluwer. https://doi.org/10.1007/0-306-48221-5_12.
- Central Committee of the Communist Party of China (2016). *The 13th Five-Year Plan for economic and social development of the People’s Republic of China*. Central Compilation Translation Press. https://doi.org/10.1007/0-306-48221-5_12.
- Cheruga, B., Liron, R., & Canavera, M. (2020). Ensuring children’s social protection in the Democratic Republic of the Congo: A case study of combating child labour in the copper-cobalt belt. In D. Lawson, D. Angemi & I. Kasirye (Eds.), *What works for Africa’s poorest children: from measurement to action* (pp. 273-286). Practical Action Publishing.
- Circle Economy (2019) *The circularity gap report 2019*. PACE.
- Clift, R. (1995). Clean technology—an introduction. *Journal of Chemical Technology & Biotechnology: International Research in Process, Environmental and Clean Technology*, 62(4), 321-326. <https://doi.org/10.1002/jctb.280620402>.
- COM (2019a). *Report from the Commission to the European Parliament, the council, the European Economic and Social Committee and the Committee of the Regions on the implementation of the circular economy action plan*. Retrieved May 24, 2021 from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019DC0190>
- COM (2019b). *Reflection paper towards a sustainable Europe by 2030*. COM 2019/22. Retrieved May 24, 2021 from <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM%3A2019%3A22%3AFIN>
- Cooper, T. (1999). Creating an economic infrastructure for sustainable product design. *Journal of Sustainable Design* 8, 7-17.
- Desrochers, P. (2002). Industrial ecology and the rediscovery of inter-firm recycling linkages: historical evidence and policy implications. *Industrial and Corporate Change*, 11(5), 1031-1057. <https://doi.org/10.1093/icc/11.5.1031>.
- Desrochers, P. (2008). Did the invisible hand need a regulatory glove to develop a green thumb? Some historical perspective on market incentives, win-win innovations and the Porter hypothesis. *Environmental and Resource Economics*, 41(4), 519-539. <https://doi.org/10.1007/s10640-008-9208-x>.
- Ember, L. (1991). *Chemical Engineering News*, July 8, 7-16.
- EU (2012). *Manifesto for a resource-efficient Europe*. Retrieved May 24, 2021 from http://europa.eu/rapid/press-release_MEMO-12-989_en.htm

- European Commission (2015). *Communication from the commission to the European Parliament, the Council, the European economic and Social Committee and the Committee of the Regions: closing the loop – an EU action plan for the circular economy*. Brussels. Retrieved May 24, 2021 from https://www.gpp.pt/images/Agricultura/Organizacao_da_Producao_e_Cadeia_Alimentar/Comunic_Precos_COM.pdf.
- European Commission (2020). *A European green deal*. Retrieved May 24, 2021 from https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
- European Communities (1975). Council directive of the 15 July 1975 on waste. 75/442/EEC. *Official Journal of the European Communities*, No. L 194/39.
- Fischer-Kowalski, M. (2003). On the history of industrial metabolism. In D. Bourg, & S. Erkman (Eds.), *Perspectives on industrial ecology* (pp. 35-45). Greenleaf Publishing.
- Fitch-Roy, O., Benson, D., & Monciardini, D. (2020). Going around in circles? Conceptual recycling, patching and policy layering in the EU circular economy package. *Environmental Politics*, 29(6), 983-1003. <https://doi.org/10.1080/09644016.2019.1673996>.
- Friant, M.C., Vermeulen, W.J., & Salomone, R. (2021). Analysing European Union circular economy policies: words versus actions. *Sustainable Production and Consumption*, 27, 337-353. <https://doi.org/10.1016/j.spc.2020.11.001>.
- Frosch, R.A., & Gallopoulos, N.E. (1989). Strategies for manufacturing. *Scientific American* 261(3), 144–153.
- Geng, Y., Fu, J., Sarkis, J., & Xue, B. (2012). Towards a national circular economy indicator system in China: an evaluation and critical analysis. *Journal of Cleaner Production*, 23(1), 216-224. <https://doi.org/10.1016/j.jclepro.2011.07.005>.
- Gould, R.K., Pai, M., Muraca, B., & Chan, K.M.A. (2019). He'ike'ana ia i ka pono (it is a recognizing of the right thing): how one indigenous worldview informs relational values and social values. *Sustainability Science*, 14, 1213-1232. <https://doi.org/10.1007/s11625-019-00721-9>.
- Haberl, H., Wiedenhofer, D., Virág, D., Kalt, G., Plank, B., Brockway, P., Fishman, T., Hausknost, D., Krausmann, F., Leon-Gruchalski, B., Mayer, A., Pichler, M., Schaffartzik, A., Sousa, T., Streeck, J., & Creutzig, F. (2020). A systematic review of the evidence on decoupling of GDP, resource use and GHG emissions, part II: Synthesizing the insights. *Environmental Research Letters*, 15 065003. <https://doi.org/10.1088/1748-9326/ab842a>.
- Hardin, G. (1968). The tragedy of the commons. *Science*, 162, 1243–1248.
- Hickel, J., & Kallis, G. (2020). Is green growth possible? *New Political Economy*, 25(4), 469-486. <https://doi.org/10.1080/13563467.2019.1598964>.
- Hill, J.E. (2015). The circular economy: from waste to resource stewardship. *Waste and Resource Management*, 168, 3-13. <https://doi.org/10.1680/warm.14.00003>.
- ILO, (2017). *Worst forms of child labour convention, 1999 (No. 182) - Democratic Republic of the Congo*. Retrieved may 24, 2021 from http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:13100:0::NO::P13100_COMMENT_ID:3331022.
- Jacobs, M. (1996). What is Socio-Ecological Economics? *Ecological Economics Bulletin*, 1, 14-16.

- Jansson, A.M. (1984). *Integration of economy and ecology: an outlook for the eighties*. University of Stockholm Press.
- Jonas, A.E.G. (2012). Region and place: regionalism in question. *Progress in Human Geography*, 36, 263. <https://doi.org/10.1177%2F0309132510394118>.
- Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: an analysis of 114 definitions. *Resources Conservation and Recycling*, 127, 221-232. <https://doi.org/10.1016/j.resconrec.2017.09.005>
- Korhonen, J., Nuur, C., Feldmann, A., & Birkie, S.E. (2018). Circular economy as an essentially contested concept. *Journal of Cleaner Production*, 175, 544-552. <https://doi.org/10.1016/j.jclepro.2017.12.111>.
- Li, Y., Wu, H., Shen, K., Hao, Y., & Zhang, P. (2020). Is environmental pressure distributed equally in China? Empirical evidence from provincial and industrial panel data analysis. *Science of The Total Environment*, 718, 137363. <https://doi.org/10.1016/j.scitotenv.2020.137363>.
- Liu, S.X. (2016). Innovation design: made in China 2025. *Design Management Review*, 27(1), 52-58. <https://doi.org/10.1111/drev.10349>.
- Mathews, J.A., & Tan, H. (2016). Circular economy: lessons from China. *Nature News*, 531, 440-442.
- Millar, N., McLaughlin, E., & Börger, T. (2019). The circular economy: swings and roundabouts? *Ecological Economics*, 158, 11-19. <https://doi.org/10.1016/j.ecolecon.2018.12.012>.
- McDonough, W., & Braungart, M. (2002). Design for the triple top line: new tools for sustainable commerce. *Corporate Environmental Strategy* 9(3), 251-258. [https://doi.org/10.1016/S1066-7938\(02\)00069-6](https://doi.org/10.1016/S1066-7938(02)00069-6).
- Murray, A., Skene, K. & Haynes, K. (2017). The circular economy: an interdisciplinary exploration of the concept and application in a global context. *Journal of Business Ethics*, 140, 369-380. <https://doi.org/10.1007/s10551-015-2693-2>.
- Njeru, S.N. (2018). Advancing Afrikan Indigenous Sustainable Practices for Transformative Development: The Mau Ogiek People, Kenya. Proceeding of the 1st Annual International Conference held on 17th-19th April 2018, Machakos University, Kenya.
- Norström, A., Balvanera, P., Spierenburg, M., & Bouamrane, M. (2017). Programme on ecosystem change and society: knowledge for sustainable stewardship of social-ecological systems. *Ecology and Society*, 22, 47.
- Paasi, A. (2003). Region and place: regional identity in question. *Progress in Human Geography*, 27, 475-485. <https://doi.org/10.1191%2F0309132503ph439pr>.
- Parkins, E. (1930). The geography of American geographers. *The Journal of Geography*, 33(6), 221-230.
- Pettis, M. (2020). The problems with China's "Dual Circulation" economic model. Financial Times 25 August, 2020. Retrieved May 24, 2021 from <https://www.ft.com/content/a9572b58-6e01-42c1-9771-2a36063a0036>.
- Pigou, A.C. (1920). *The economics of welfare*. Macmillan.
- Potocnik, J. (2013). EU eyes circular economy, global partnership. New Europe. Retrieved May 24, 2021 from <https://www.neweurope.eu/article/commissioner-potocnik-eu-eyes-circular-economy-global-partnership/>

- Prendeville, S., Hartung, G., Brass, C., Purvis, E., & Hall, A. (2017). Circular makerspaces: the founder's view. *International Journal of Sustainable Engineering*, 10(4-5), 272-288. <https://doi.org/10.1080/19397038.2017.1317876>.
- Preston, F. (2012). *A global redesign: shaping the circular economy*. Chatham House: The Royal Institute of International Affairs.
- Real, M., Lizarralde, I., & Tyl, B. (2020). Exploring local business model development for regional circular textile transition in France. *Fashion Practice*, 12(1), 6-33. <https://doi.org/10.1080/17569370.2020.1716546>.
- Ruiz-Mallén I, & Corbera E. (2013). Community-based conservation and traditional ecological knowledge: implications for social-ecological resilience. *Ecology and Society*, 18(4), 12.
- Seneca, J.J., & Taussig, M.K. (1974). *Environmental economics*. Prentice and Hall Inc.
- Simmonds, P.L. (1875). *Waste products and undeveloped substances: a synopsis of progress made in their economic utilisation during the last quarter of a century at home and abroad*. Hardwicke and Bogue.
- SETAC (1991). *A technical framework for life-cycle assessments*. Society of Environmental Toxicology and Chemistry.
- Skene, K.R. (2018). Circles, spirals, pyramids and cubes: why the circular economy cannot work. *Sustainability Science*, 13, 479-492. <https://doi.org/10.1007/s11625-017-0443-3>.
- Skene, K.R. (2019). *Artificial intelligence and the environmental crisis: can technology really save the world?* Routledge.
- Skene, K.R. (2020). No goal is an island: the implications of systems theory for the Sustainable Development Goals. *Environment, Development and Sustainability* (2020). <https://doi.org/10.1007/s10668-020-01043-y>.
- Skene, K.R., & Murray, A. (2017). *Sustainable economics: context, challenges and opportunities for the 21st-century practitioner*. Routledge.
- Stahel, W.R., & Reday-Mulvey, G. (1976). *Jobs for tomorrow: the potential for substituting manpower for energy*; study no. 76/13, for DG Manpower, European Commission.
- Stern, D.I. (2004). The rise and fall of the environmental Kuznets curve. *World Development*, 32(8), 1419-1439. <https://doi.org/10.1016/j.worlddev.2004.03.004>.
- Tan, Z. (2008). Circular economy and renewable resource industry in China. CESC Contribution for the 4th EU-China Round Table on Recycling Industries, 6/7 November 2008, Paris.
- UNEP (1990). Division of Technology, Industry, and Economics (DTIE), Sustainable Consumption & Production Branch (SCP), themes: resource efficient and cleaner production. Retrieved May 24, 2021 from <http://www.unep.fr/scp/cp/>
- Vonkeman, G.H. (1996). International co-operation: the European Union. In A. Blowers & P. Glasbergen (Eds.), *Environmental policy in an international context: prospects* (pp. 105-134). Arnold.
- Ward, J.D., Sutton, P.C., Werner, A.D., Costanza, R., Mohr, S.H., & Simmons, C.T. (2016). Is decoupling GDP growth from environmental impact possible? *PloS one*, 11(10), 0164733. <https://doi.org/10.1371/journal.pone.0164733>.

- Wu, H.Q., Shi, Y., Xia, Q., & Zhu, W.D. (2014). Effectiveness of the policy of circular economy in China: A DEA-based analysis for the period of 11th five-year-plan. *Resources, Conservation and Recycling*, 83, 163-175. <https://doi.org/10.1016/j.resconrec.2013.10.003>.
- Yang, Y. (2020). China's bold new Five-Year Plan. East Asia Forum. Retrieved May 24, 2021 from <https://www.eastasiaforum.org/2020/12/13/chinas-bold-new-five-year-plan/>
- Zhang, B. (2013). Market-based solutions: An appropriate approach to resolve environmental problems. *Chinese Journal of Population Resources and Environment* 11, 87–91. <https://doi.org/10.1080/10042857.2013.777526>
- Zhang, K.M., & Wen, Z.G. (2008). Review and challenges of policies of environmental protection and sustainable development in China. *Journal of Environmental Management*, 88(4), 1249-1261. <https://doi.org/10.1016/j.jenvman.2007.06.019>.