Geo

Open Access

Geography and Environment

The global green economy: a review of concepts, definitions, measurement methodologies and their interactions

Lucien Georgeson[1], **Mark Maslin**[1] and **Martyn Poessinouw**[1,2]

Over the past decade, the green economy has emerged as an important policy framework for sustainable development in both developed and developing countries. It presents an attractive framework to deliver more resource efficient, lower carbon, less environmentally damaging, more socially inclusive societies. There are tensions between competing green economy discourses and a number of different definitions exist, all of which have major shortcomings. This is further complicated by the different underlying concepts of the 'weak', 'transformational' and 'strong' green economy. Several important definitions focus on the aspirational 'transformational green economy'. To enable and to track this 'transformation', economic and environmental measurement is essential. Current approaches are still in development, lack available data or show inconsistencies with proposed definitions, and thus may neither support effective decision-making nor efforts to transform economies. This review identifies these current shortcomings and makes four overarching recommendations for improving measurement for green economy transformations, including cheaper, faster and more widely available data, and broader frameworks for measuring economy–society–environment interactions. We suggest that proper measurement of the green economy needs to move beyond GDP as the central measure of progress and to better track the 'transformational green economy'. This will enable the green economy to become relevant again at national and international levels, given the emerging Sustainable Development Goals and post-COP 21 frameworks.

Key words green economy; green growth; sustainable development; policy assessment; measurement; indicators

[1]Department of Geography, University College London, Pearson Building, Gower Street, London WC1E 6BT
E-mail: lucien.georgeson.13@ucl.ac.uk; m.maslin@ucl.ac.uk
[2]kMatrix Ltd, Greetham House, Greetham, Rutland LE15 7NF
E-mail: martyn@kmatrix.org

Revised manuscript received 20 February 2017

Geo: Geography and Environment, 2017, 4 (1), e00036

Introduction

It is widely accepted that only collective economic adjustment on a global scale can avert the dangerous consequences of environmental degradation and climate change (Stern 2006). The concepts and discourses of the green economy represent a radical transition for more efficient, environmentally friendly and resource-saving technologies to reduce emissions and mitigate the effects of climate change (Jänicke 2012), and tackle resource depletion and serious environmental degradation. Its discourses have strategic merit in reframing a negative debate around constraints into a positive one about opportunities (Bowen and Fankhauser 2011). The green economy concept also has the potential to ensure that, when national, regional and international implementation plans are designed, the Sustainable Development Goals (SDGs) and the post-2015 development agenda can overcome inherent conflicts between the goals.

The green economy concept has gained popularity in international, regional and national policy circles: initially as a response to the financial crisis (Bina and La Camera 2011), but also a motor for growth and development. It is an operational policy agenda to achieve measurable progress at the environment–economy nexus (Schmalensee 2012), as a 'pillar' of sustainable development implementation to lead the

 ISSN 2054-4049 doi: 10.1002/geo2.36

transition to low carbon, green economies. As of today, green economy concepts and frameworks have influenced discourses and policy in many countries. These include the UK, France and China with a greater focus on growth (Bailey and Caprotti 2014), a number of countries in Africa (such as Rwanda, Morocco, Ethiopia, Senegal and South Africa) with emphasis on its ability to deliver transformations that 'leapfrog' current high-pollution development paradigms (United Nations Environment Programme 2015, hereafter UNEP), and perhaps with a greater link to socioeconomic challenges and resilience in the Asia-Pacific region (United Nations Economic and Social Commission for Asia and the Pacific *et al.* 2012, hereafter UNESCAP). Green economy discourses are also gaining traction in various sub-national jurisdictions, such as the state of Mato Grosso, Brazil (UNEP 2016). In its scale, the green economy is becoming a significant part of the global economy; revised estimates of global investment in 'clean energy' alone in 2015 suggest a figure of $348.5 billion (Bloomberg New Energy Finance 2016a, hereafter BNEF), with global investments between now and 2040 projected to be $7.8 trillion (BNEF 2016b).

Green economy frameworks and practices are highly relevant to ongoing debates on the types of economic and societal reorganisation necessary to achieve environmental sustainability, emissions reductions, social justice, and stable economies. For example, to reduce global carbon emissions, radical changes in energy policy are required. The International Energy Agency (IEA) suggested that globally we only have until 2017 to shift to a 450 ppm CO_2 trajectory before the lock-in effect of existing infrastructure would require all investments made between 2020 and 2035 to be zero emissions options (IEA 2007). This entails a fundamental shift in resource use, which has not previously been a significant factor in policy. Moreover, progress towards achieving such transitions at national, regional and international levels must be measured, so future policies can be developed as required.

The SDGs, officially announced in September 2015, create a new imperative for the green economy. Though only partially successful, the Millennium Development Goals (MDGs) established the principle that measuring key indicators can improve our ability to tackle major issues. With the SDGs, the process begins to deliver significant positive changes by 2030. In negotiations, green economy discourses had a lesser role than during Rio+20; we suggest that it must be realigned as a major part of SDG implementation. With this review, we seek to create a new imperative for clarifying the aims of green economy concepts and discourses, and measurement of green economy practices.

A balanced framework for green economy actions must be complemented by comprehensive, relevant frameworks for measuring progress. Policies need effective measurement and indicators can improve the level of debate on the green economy and inform the wider public (Vossenaar 2013). The Green Growth Knowledge Platform (GGKP), an initiative of various international organisations, noted the importance of measuring green growth-related economic opportunities and transitions, and the assessment of environment-related policy tools in the measurement agenda (GGKP 2013). The United Nations' System of Environmental-Economic Accounting (SEEA), a global effort to implement agreed accounting standards, states that measuring the financial commitment of an economy to environmental protection can evaluate the influence of environmental protection costs on international competitiveness (United Nations 2014b). However, there are many examples of unintended consequences of policy performance measurement (Smith 1995; Bevan and Hood 2006; Fukuda-Parr 2014); therefore measurement and indicators should be analysed in concert with green economy concepts to understand whether they support or constrain efforts to implement these visions.

The global green economy cannot be simply GDP growth driven by a 'green stimulus', because GDP growth containing some 'greenness' cannot be proved to deliver the necessary and urgent changes in resource use, emissions and consumption patterns required to negate environmental degradation, resource depletion and climate change. However, the 'greening' of economies is not necessarily a drag on growth (Schmalensee 2012). The rapid pace of development in emerging economies presents great opportunities for green economy transitions. Sierra Leone aims to transition to middle-income status based on a 'green growth' strategy, envisaging the next five years as the most transformative in its history (African Development Bank 2014, hereafter AfDB). Transformation emerges as an important term for the green economy. In relation to adaptation, Pelling *et al.* describe transformative actions as those 'that have the reach to shift existing systems (and their component structures, institutions and actor positions) onto alternative development pathways' (Pelling *et al.* 2014, 114). Such an understanding of transformation has great relevance for framing green economy responses to national and global challenges.

This review evaluates major international and national efforts to define green economy concepts and, uniquely, current efforts to measure the practices and impacts of the green economy. Green economy concepts have great potential for emerging sustainable development discourses but could be side-lined by the SDGs and the Paris Agreement. The review assesses the development of green economy concepts and visions, and the typologies of competing concepts. It proposes a

ISSN 2054-4049 doi: 10.1002/geo2.36

realigned definition of the 'transformational green economy'. The review then explores key programmes and standards relating to measuring the impacts and practices of the green economy, how measurement interacts with concepts and visions. Without effective measurement, it will be difficult to assess policy efficacy, define and measure the potentially transformative role of green economy concepts in this new policy space, or achieve green economy goals for sustainable development and climate action. Finally, we make four recommendations to improve measurement for green economy transformations.

The development of the green economy concept

The aftermath of the 2008–9 global financial crisis represented a perfect storm for the green economy's international rise; 'The combined forces of global economic recession, humanly induced environmental change and stark social inequalities have led to international calls for a radical transformation of current development practices and transitions towards a 'green economy'' (Davies 2013, 1285). However, the concept itself first emerged with Pearce *et al*.'s (1989) *Blueprint for a green economy* for the UK's Department for the Environment.

The green economy's conceptual foundation recognises that the separation of economic development and environmental policies is artificial (Barbier 2013). The United States, China and South Korea labelled their stimulus packages as 'Green New Deals' (Zysman *et al.* 2012); the rationale was that green fiscal stimuli provide a boost to the economy, whilst also laying the foundations for sustainable and more stable growth in the future (Bowen *et al.* 2009). Such measures recognise that economic recovery and climate change responses are not in opposition (Bowen *et al.* 2009). Green growth was positioned as a more attractive alternative to economic recovery than returning to 'brown' growth (van der Ploeg and Withagen 2013). Although they were 'one-off' policies, temporary interventions can deliver sustainable long-term growth when the sustainability of the inputs is assured (Acemoglu *et al.* 2012).

The size and number of 'Green New Deals' notwithstanding, the green economy already existed at scale; green technology firms alone were worth $284 billion globally in 2008 (Caprotti 2010). By way of context, fossil fuel subsidies reached $523 billion globally by 2011, compared with $88 billion for subsidies for renewable energy (IEA 2012). The two new agreements that mark the start of the SDG and Habitat III era can function as a moment of realignment (Caprotti *et al.* 2017). A moment of crisis can also represent an opportunity to act; the 'green' responses to financial crisis partially represent a return to greater levels of statism and the re-legitimisation of intervention (Death 2015). Therefore, a crisis event may create a 'window of opportunity' for new strategies or radical reform (Aberbach and Christensen 2001).

After 2009, the green economy evolved into a broader policy framework. In 2012, the United Nations Conference on Sustainable Development (UNCSD, or Rio+20) was a focal point for the green economy internationally. There was qualified hope in the build-up that Rio+20 would generate enough progress to give the concept the necessary political and financial backing, or at least recognition of a more central role in international policy debates (Damon and Sterner 2012; Martinelli and Midttun 2012; Sierra 2012; Zysman *et al.* 2012).

Clark commented that 'Rio+20 emphasizes that economies must be made both green and inclusive. It singles out poverty eradication as the world's most pressing challenge' (2013, 19). However, many commentators concluded that the UNCSD was a missed opportunity to make the green economy central to international policy debates (Clémençon 2012; Halle 2012; Powers 2012; Barbier 2013). Although the green economy was a 'theme', the conference lacked a 'vision' (Bernstein 2013) and its outcome document, *The future we want*, failed to lay out a coherent roadmap (Clémençon 2012).

The green economy must coexist with other sustainable development concepts. The Economics of Ecosystem and Biodiversity's (TEEB) green economy report describes a clearer hierarchy (ten Brink *et al.* 2012), represented in diagrammatical form in Figure 1. Following this hierarchy, there is no conceptual inconsistency with sustainable development, challenging the artificially imposed barriers around policy debates. However, these terms are not frequently used in alignment with this hierarchy.

In some ways, public support for the green economy has faltered since the 'Green New Deals' with their strong focus on economic growth (Barbier 2015) and the immediacy of the financial crisis. The SDGs could shape the green economy's development post-Rio+20 (United Nations 2014a). The goals and targets, announced at the UN General Assembly in September 2015, could bring greater attention to the practices of the green economy after Rio+20's relative lack of success. However, green economy discourses were absent from most delegations' statements during negotiations. As analysis begins on how to achieve the goals, green economy discourses need to gain a key position within SDG implementation. Moments of agreement on shared goals and collective action also present opportunities to move beyond goal setting to implementation in a way that can be transformative (Stevens and Kanie 2016), creating the spaces to deploy

ISSN 2054-4049 doi: 10.1002/geo2.36

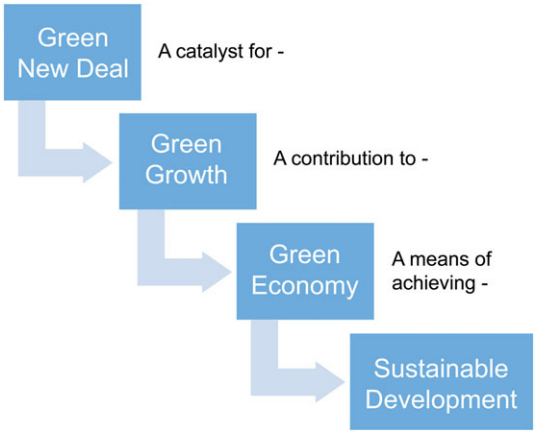

Figure 1 The hierarchy of green economy concepts (based on the conceptualisation of TEEB in ten Brink *et al.* 2012)

green economy discourses in national and sub-national contexts. A greater understanding will also be required of how to differentiate North–South and national priorities in the implementation of green economy plans, exemplified by the role of green economy discourses in state-led transformation in China, given its unique institutional structure (Gupta and Wong 2014). Other reports demonstrate how national green economy visions vary between different continents (UNEP 2011; AfDB 2012; UNESCAP *et al.* 2012). While recognising the shortcomings of green economy concepts, there is 'the capacity for green economy discourses and initiatives to bring genuine benefits to citizens of the global South' (Caprotti and Bailey 2014, 199).

Current green economy definitions

Several studies have analysed international organisations' green economy or green growth definitions. Bina and La Camera (2011) analysed six international-scale responses to the 'double crisis' (climate change and the financial crisis), concluding that these policies uphold mainstream economics' interpretation of the environment and they are primarily concerned with economic recovery. Borel-Saladin and Turok (2013) examine the green economy definitions of the UNEP, the Organisation for Economic Co-operation and Development (OECD) and the World Bank. They conclude that, a few caveats notwithstanding, the green economy provides the tools required to transform economic activity for healthier environments and more inclusive economies. Their criticisms of green economy concepts are: being too closely aligned to current systems, not considering potential limits to growth, oversimplification, misplaced optimism and questions over the models used. While comprehensive comparisons, neither study discusses the measurement of green economic activity. Other studies that have assessed some green economy definitions and discourses are Brown *et al.* (2014) and Death (2015).

Ferguson's (2014) study of green economy discourses concludes that *green growth* discussions must be separated from *green economy* discussions. Ferguson identifies many tensions in green economy discourses. His study also identifies three categories of green economy discourse: *weak*, *transformational* and *strong*. Part of this categorisation includes assessing measurement, focusing on their relationship to GDP.

There is a growing body of literature on the importance of 'transformation' concepts to address deep-rooted, complex challenges; herein we aim to further Ferguson's conceptualisation of *transformational*. As Meadowcroft concludes, 'the state has been forced to accept that an ever more profound transformation of economic activity and of political and legal obligations will be required if environmental problems are to be managed' (Meadowcroft 2012, 69). The work of Pelling and others on transformation and adaptation suggests a potential relationship for transformation and the green economy. Transformation can be an enabling focus for approaches that address underlying causes and create the potential for dynamic and inclusive change, as opposed to other risk management formulations that aim to reduce stresses on the status quo (Pelling and Manuel-Navarrete 2011; Pelling *et al.* 2014). Death (2015, 2216) recognised four green economy typologies, one of which was 'green transformation', characterised by calls for the model of economic growth to be transformed in ways that involve 'explicitly political interventions into transforming the structure of the economy'. Death's typologies are based on a more specific focus on national strategies from the global South, which represents a very important contribution to the literature, but differs from the aims of this review. We have focused on building on Ferguson's three typologies as we believe that it represents an effective evolution of the 'weak/strong' dichotomy from 'sustainability' definitions, providing a useful basis for a framework for this review of green economy visions and their interactions with efforts to measure progress.

The reports analysed in this review are summarised in Table I. Reports were selected as key reports from international organisations, and important regional, national and academic conceptualisations of the green economy, from a literature review focused (but not exclusively) on the period of build-up to and aftermath of Rio+20 (2010–13). We find that, in agreement with Ferguson, the *strong green economy* generally only exists within academic literature. We have also included reports labelled as 'green growth' as the difference in

ISSN 2054-4049 doi: 10.1002/geo2.36

Table I Green economy and green growth reports

Organisation/ authors	Title	Green economy typology	Key aspects of definition	Measurement agenda	Key shortcomings
European Commission	*Europe 2020: a strategy for smart, sustainable and inclusive growth* (2010)	Weak/ transformational	Operationalisation of the green economy paradigm at EU level. Green economy broadly defined as 'smart, sustainable and inclusive growth'. Defined by 'Flagship Initiatives' ('Resource efficient Europe', 'An industrial policy for the globalisation era').	National and EU level indicators, aligned with Eurostat.	Thematic areas are broad (resource efficiency, headline emissions targets) but do not cover the full spectrum of the green economy.
OECD	*Towards green growth* (2011)	Weak	Good economic policy at the heart of green growth. Economy must be 'flexible', 'dynamic' and more resource efficient Economy and environment as 'mutually reinforcing'. Innovation is key.	30 OECD green growth indicators. Furthers OECD's work to identify other indicators to accompany GDP.	Unequivocal support for potential of unlimited 'green' growth. Economic-policy-as-usual scenario (innovation, productivity, technology) with added environmental benefits.
UNEP	*Towards a green economy* (2011)	Transformational	Moving towards a green economy can be profitable, it is possible to combine healthy living with strong economic growth. Economic growth will be healthier, stronger and more vigorous with this transformation than without it. (Brockington 2012). More focus on social aspects of green economy.	Questions role of GDP in assessing well-being. Focuses on indicators for decision-making and policy design.	Solutions offer little innovation. Despite initial critical assessment of current production and consumption, only proposes mainstream sustainable development based on markets, technology and regulation (Brockington 2012).
HM Government	*Enabling the transition to a green economy* (2011)	Weak	Based on need for strong, sustainable and balanced growth and strong economic arguments for immediate action on climate change. Green economy defined by its benefits to the UK economy: new international markets to be captured and opportunities for growth.	Government to provide information on expected impacts of climate change and resource risks. Measurement not on 'Policy Timeline'.	Social imperatives of the green economy are absent. Regulation framed as solely a burden on businesses and businesses positioned the ultimate beneficiaries of green economy policies.
World Bank	*Inclusive green growth* (2012)	Weak	'Inclusive green growth is the pathway to sustainable development' (World Bank 2012, xi). 'Growth itself is good, but it has not been green or inclusive enough'.	How green policies affect conventionally measured GDP. Incorporating the environment into accounting,	Insistence that growth must be green but not slower. Narrow range of economic perspectives considered. Heavily reliant on existing solutions.
GGKP	*Moving towards a common approach on green growth indicators* (2013)	Weak	Claims existing definitions have a lot in common. States no definition of its own for its 'common approach'.	Approach based on communication need, not monitoring. Adopts OECD's headline indicators. Wealth accounting as complementary.	Masks green economy under green growth. Bases indicators on natural assets as input to a production function only.

(*Continues*)

ISSN 2054-4049 doi: 10.1002/geo2.36

Table I (*Continued*)

Organisation/ authors	Title	Green economy typology	Key aspects of definition	Measurement agenda	Key shortcomings
United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)	*Green growth, resources and resilience: environmental sustainability in Asia and the Pacific* (2012)	Transformational	Explicit focus on the green growth objectives of the Asia-Pacific region. Highlights connection between green growth and poverty reduction, and importance of resilience and mitigation for many countries in the region.	Indicator-based approach, different issues to OECD.	Focus on green growth, no criticism of growth. Highlights difficulties in comparisons between regions.
Global Green Growth Institute (GGGI)	Various (the GGGI, has not released a comparable report; it focuses on green growth implementation across various national contexts)	Weak	'Green growth seeks to fuse sustainable development's economic and environmental pillars into a single intellectual and policy planning process, thereby recasting the very essence of the development model so that it is capable of producing strong and sustainable growth simultaneously' (Samans 2013, 3). Policy frameworks will be context specific. Resilience, equity and inclusivity are important.	Based on GDP. Set by particular national contexts.	'Economic growth should remain a driver of welfare improvements and poverty reduction' (GGGI 2014).
Barbier	Various publications (Barbier 2011 2015)	Transformational/ strong	Policies need to deliver economy-wide innovation and structural transformation. Rising ecological scarcity shows current economic development is unsustainable.	Full environmental valuation and accounting for natural capital depreciation. Better information on the environment is vital.	Transformational agenda requires much more data. Political will for institutional transformations may be lacking.
Cato, Jackson and Victor	Various (Cato 2009; Jackson and Victor 2011)	Strong	Academic *strong green economy* literature varies from green and ecological economics to de-growth and no growth perspectives.	Rejection of GDP. Broader measures of welfare and the environment.	Limited influence on policy-making so far. Difficulty in communicating de-growth and no growth positions more broadly.

ISSN 2054-4049 doi: 10.1002/geo2.36

discourse is perhaps deliberately obscured. The majority fall between *weak* and *transformational*.

UNEP's *Towards a green economy* has perhaps received the most critical attention. Its profile was heightened by its association with Rio+20 and it is more clearly *transformational*. UNEP makes an explicit attempt to model future green economies and questions whether existing measures of economic performance, such as GDP growth, are adequate for assessing human wellbeing. The report provides a detailed study of the enabling conditions required for green economy transitions (UNEP 2011). It makes the economic case for shifting public and private investment to transition to a green economy, offering greater support for heterogeneous economic thinking and the strongest criticism of current modes of production and consumption. UNEP comments significantly on the importance of national GE and North–South differences, which is important for mobilising green economy concepts to respond to different national challenges and influence transformations.

However, their modelling was criticised by Victor and Jackson (2011) because the green economy futures model assigns more funding to the green economy than the 'business-as-usual' scenario; calling into question the conclusion that a green economy would grow faster. Victor and Jackson also question whether the policies proposed would reduce emissions sufficiently by 2050 to achieve the 450 ppm CO_2 target suggested by the fourth Intergovernmental Panel on Climate Change (IPCC) report, if global temperature rise were to be kept below 2°C (IPCC 2007).

The OECD and World Bank reports show that certain ideas of environmental economics and policy have now reached international policy-makers. The OECD recognises 'natural capital as a factor of production and its role in enhancing well-being' (OECD 2011, 20). *Inclusive green growth* draws strong conclusions on the barriers to green growth, the short-term foci required and the need to recognise local contexts (World Bank 2012). These conclusions, while not new, are now more central in global policy debates and thus have greater influence over policy-makers.

The World Bank demonstrates most clearly *weak green economy* discourses and their uncritical assumptions of the role of economic growth in development. Their reasoning is that growth is good, but it has not been green or inclusive enough:

> Over the past 20 years economic growth has lifted more than 660 million people out of poverty and has raised the income levels of millions more, but growth has too often come at the expense of the environment … Growth has not been inclusive enough … sustained growth is necessary to achieve the urgent development needs of the world's poor and that there is substantial scope for growing cleaner without growing slower.
>
> (World Bank 2012, xi)

Growth has not been consistently positive for poverty reduction. Just 1.2% of global GDP growth between 1999 and 2008 went to the poorest 30% of global population (Woodward 2013). While growth may have lifted 660 million out of poverty, 1.2 billion people still lived on less than $1.25 a day in 2010 (World Bank 2013). Rate is not necessarily key; to deliver lasting change, growth that is environmentally sustainable (i.e. 'green') and can be sustained over the long term would be a better aim for *green growth* policies. *Weak green economy* and *green growth* frameworks rely on merely harnessing the green economy for economic growth. This is a source of significant criticism of certain green economy discourses and, more broadly, general scepticism about green economy concepts (Brockington 2012; Brown *et al.* 2014; McAfee 2016).

UNESCAP's report demonstrates the tension between national priorities and international discourses. UNESCAP states the links between environmental and social challenges, such as water security and access to clean water. Compared with the EU, national-level priorities are very different within the region. This presents challenges for measuring the green economy, requiring additional indicators (UNESCAP 2012).

There are signs that green growth and green economy concepts are left deliberately imprecise. The UK's report suggests a narrow definition of green economy practices, conflicting with its own rhetoric that 'A green economy is not a sub-set of the economy at large – our whole economy needs to be green. A green economy will maximise value and growth across the whole economy' (HM Government 2011, 4). An unresolved tension persists between attempts to describe a green economy transition for the whole economy and the concurrent existence of descriptions of green economy practices as a subset of the economy. The example of the UK also demonstrates that nationally defined green economy policies, even where they respond to national contexts, still need to be analysed critically. The UK's narrow focus may not deliver the necessary transformations. Here we can contrast the UK's approach with the assessment of China's green economy by Gupta and Wong (2014).

The lack of green growth/economy differentiation and the weak/transformational green economy overlap (where definitions appear transformational but have the same basis on economic growth) may be deliberate. UNEP and the World Bank are trying to make economic cases for the green economy to governments sceptical of calls to abandon the growth paradigm, especially in developing countries.

ISSN 2054-4049 doi: 10.1002/geo2.36

The green economy concept has been criticised for significantly overlapping with sustainable development, or attempting to replace it. Brand (2012) calls the green economy 'the next oxymoron' after sustainable development because neither can be precisely defined. The green economy is an attractive term for powerful socioeconomic actors and thus has the potential to be hijacked. It must reflect differing social, economic and cultural contexts. However, it is too simplistic to call both terms oxymora. Lorek and Spangenberg (2014) argue that the green economy concept does not support the original 'Brundtland' sustainability criteria and relies on optimistic predictions of future technologies. The green economy is not conceptually without flaw; however, it could generate action at scale in policy and industry. It goes further than sustainable development to confront the artificial separation of environment and economy, by creating a policy framework to achieve economic progress with lower environmental impacts.

It has been suggested that definitions are aligning (World Bank 2012), however there are still organisations interpreting it differently for their own goals (Schmalensee 2012). This could demonstrate that green economy aims are universal and its framework flexible enough for different contexts. Or, it could be open to the same crisis of interpretation as sustainable development. The establishment of the GGKP appears to suggest that UNEP, OECD, the World Bank and the GGGI are coalescing around a shared definition. This is positioned as a genuine effort to align the disparate reports already produced on monitoring *green growth* (Kamp-Roelands 2013; OECD 2011; UNEP 2012a 2012b 2014b). However, this also serves to maintain the green growth/green economy ambiguity, crowd out *strong* discourses and post-growth concepts, and obscure *transformational green economy* discourses amongst commitments to an economic growth as usual. There may be some agreement on broad 'green' aims and the hierarchy of TEEB (Figure 1) stands up in theory, however these terms are often used interchangeably. The green economy represents contested discourses and concepts (Ferguson 2014), however the World Bank and GGKP might attempt to airbrush out the differences. Greater collaboration is taking place, but these concepts still compete as different organisations seek to gain influence in the international green economy domain.

Contemporary drivers of the green economy: SDGs, climate change and national priorities

UNEP argues that achieving sustainability almost entirely depends on getting the economy 'right' (UNEP 2011). The green economy could be interpreted as an appropriate means of refocusing sustainable development upon the most important means of delivering it and the intrinsic links between economy and environment. In this way, positioned between societal goals and outcomes, the green economy can be conceptualised as an 'enabler' for sustainable development (Figure 2). Achieving societal goals can lead towards sustainable development as an outcome. The 'enablers' illustrated are examples of the many things required to achieve sustainable development, and there are certainly interactions between them (the green economy is aided by natural capital valuation, and requires sustainable urbanism as both a foundation and a co-process, for example). Green economy strategies can align with sustainable development as the outcome to be achieved (or in Rio+20 terms, *The future we want*).

The green economy has received less attention since Rio+20, but there are two major contemporary opportunities to refocus efforts on global environmental challenges and the contribution green economy concepts can make. The SDGs provide a platform for reintegrating the green economy into the sustainable development agenda. As the Secretary General's synthesis report indicates by linking the SDGs to the UN Charter, and the Declaration on the Right to Development (Omilola 2014), the SDGs will become central to international development. However, potential conflicts exist between the proposed SDGs (Waage and Yap 2015). For example, there are challenges where the different targets for energy, water and climate change overlap (Georgeson and Maslin 2014). Green economy frameworks can prevent perverse outcomes from implementing the SDGs, which work at cross purposes. The green economy can regain its momentum from pre-Rio+20 and become a key enabler for achieving the SDGs.

The COP 21 negotiations in Paris in 2015 (under the UN Framework Convention on Climate Change) delivered a binding treaty that comes into force in 2020, providing another imperative for successfully 'renewing' green economy concepts. Limiting warming to below 2°C (with a high probability) would require global emissions to peak in 2020, reach zero emissions between 2060 and 2080, then negative annual emissions until 2100 (and CO_2 emissions from fossil fuel combustion and industry would need to reach zero between 2045 and 2065) (Hare *et al.* 2014). Although current emissions reduction commitments do not represent sufficient reductions to limit temperature rises to 2°C (Evans and Yeo 2015), recognition of low carbon transition opportunities could be a powerful tool for stronger reduction commitments (Stern 2014) under the agreement's 'ambition' mechanism. Green economy approaches could also demonstrate the

ISSN 2054-4049 doi: 10.1002/geo2.36

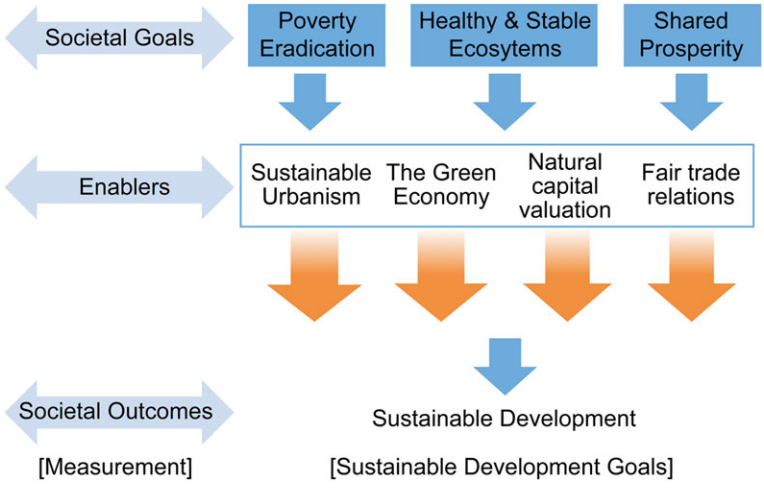

Figure 2 Visualising the green economy between societal goals and outcomes

economic opportunities of low carbon transitions ahead of the 2025 deadline for agreeing a new collective carbon finance goal (United Nations 2015).

As previously noted, there are significant differences in national and North–South priorities and understandings of the green economy (Death 2015; Morrow 2012); therefore green economy responses could be deployed for national and sub-national transformations where discursive spaces are created. There are numerous examples of green economy concepts being deployed to respond to national priorities on environmental and social challenges (AfDB 2014; Gupta and Wong 2014; Republic of Rwanda 2011; Sonnenschein and Mundaca 2015).

Refocusing green economy definitions

There has been an institutional embrace of the green economy, but without a detachment from conventional growth discourses (Ferguson 2014). While recognising that it is highly complex (Bailey and Caprotti 2014), the critiques of differing definitions demonstrate that there should be an effort to delimit the green growth/green economy concepts, to prevent its arbitrary use (Stepping and Stoever 2014). As the *strong green economy* generally only exists within academic literature, and the *weak green economy* offers little that differs from conventional development paradigms, the *transformational green economy* appears as the contemporary definition that is both possible and forceful enough to deliver genuine progress (and perhaps significant transformations would render *strong green economy* discourses feasible in the future). The green economy should be growth agnostic; while economic growth may occur, it is neither a goal nor an indicator of wellbeing. While growth is often used as a synonym for wellbeing, the *transformational green economy* could use the frame of economic security (Ferguson 2014).

Furthermore, transformation has already been deployed as an organising concept in relation to climate change adaptation in particular (Pelling *et al.* 2014), notably for its abilities to recognise various needs across different scales and point towards dynamic changes to a system to allow it to thrive a changing environment. The processes of incremental improvement deployed in earth system governance since 1972 are no longer sufficient (Biermann *et al.* 2012); more radical transformation through structural change is required.

However, as seen in Table I, even some *transformational* definitions do not fully embrace alternatives to a conventional growth paradigm. Moreover, the SDGs adopted the title 'Transforming our world by 2030', but continue to support an economic-growth-as-usual paradigm. Therefore, staking out what a transformational green economy should entail across different scales is required. With the SDGs, the transformative potential contained within agreeing goals is not the end point but the start of influencing action (Stevens and Kanie 2016). Therefore, to redirect definitions of the *transformational green economy* and to ensure that measurement options and policy proposals exist to ensure the viability of transformational approaches, we put greater emphasis on alternative, more inclusive measures of social, environmental and economic progress. This aligns with the broader measures of progress required by the SDGs' indicator agenda and the ecological and social rearticulations of the green economy outlined by Ferguson, but moves beyond debates relating to GDP. The 'beyond GDP' discourse is very relevant and remains an important argument for the *transformational green economy* and its

ISSN 2054-4049 doi: 10.1002/geo2.36

measurement, based on significant discussions of the inadequacies of GDP for measuring wellbeing and the need to reform or reject economic growth as a target to transform the green economy concept (Ferguson 2014; Fioramonti 2014; Stiglitz *et al.* 2009). Therefore, the rest of this review will focus on other areas of measurement.

Measurement of the transformational green economy

The definitional discussion shows that the green economy is a wonderful slogan; but wonderful slogans do not always lead to wonderful actions (Schmalensee 2012). The grand vision must be underwritten with policy frameworks that balance the competing demands of the economy and environment (OECD 2011), and this policy agenda requires monitoring and evaluation to be efficient and effective (Figure 3). The feedback loops throughout this process mean that we must analyse every step carefully and understand the interactions. Although goals influence decisions on measurement, targets and indicators, the availability of data and the types of indicators considered desirable or feasible can affect both decisions about goals and the nature of progress towards those goals, often with significant unintended consequences. There are numerous examples from different fields (Bevan and Hood 2006; Fukuda-Parr 2014; Hood 2012; Smith 1995; van Thiel and Leeuw 2016) that demonstrate how data availability affects indicator choice, how targets can affect actions taken and lead to narrow progress towards an indicator target, not the original goal. We also aim to suggest where different measurement approaches are linked to or obstruct different green economy visions; given the importance of understanding how measurement interacts with its political and bureaucratic context (Hood 2012).

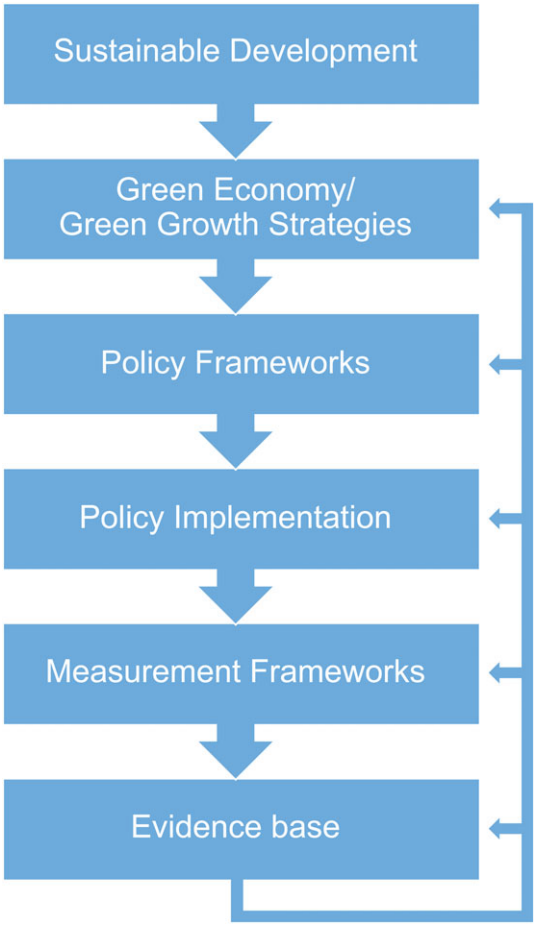

Figure 3 The role of measurement in delivering green growth/green economies

This requires comprehensive approaches for transformation and accurate, measurable and relevant indicators (Stepping and Stoever 2014). This is vital to analyse progress made, and opportunities and risks inherent in transformations, which seek to change rather than protect systems. The MDGs provide a clear example of how the characteristics and limitations of measurements and indicators can affect progress itself. Targets and goals can become irrelevant, or obstructive, when inappropriate indicators are used, indicators are based on inadequate assumptions or incomplete data, or implementation focuses too narrowly on the target rather than the goal it is intended to reflect (Attaran 2005; Satterthwaite 2003). Measurements are not 'value-neutral' and contain embedded assumptions about the nature and purpose of the activity measured (Fukuda-Parr *et al.* 2014). Such information can also communicate the need for policies to the public (GGKP 2013); but a lack of data is problematic for effective communication. International organisations are devoting considerable efforts to assisting countries in this regard, requiring analysis and discussion to assess whether such efforts contribute towards the measurement of green economy transformations, potentially deliver unintended consequences, or uphold current economic paradigms that may obstruct *transformative green economy* visions. Performance measurement has intended and unintended consequences on political decision-making, including before data are measured; the construction of the evaluation process can have impacts on how political decisions are made and operational performance goals risk leading to reductionism when tackling complex problems (Bjørnholt and Larsen 2014). Management approaches that put heavy emphasis on performance measurement may influence the types of political goals set; Bjørnholt and Larsen comment that 'if you want to exert control over the policy-making process in the era

ISSN 2054-4049 doi: 10.1002/geo2.36

of performance governance, the most important part of the process might be the translation of political objectives into operational performance goals' (2014, 408).

Here we will assess the measurement approaches of the OECD (the green growth monitoring framework), UNEP (green economy indicators for policy-making), the World Bank-led WAVES Partnership and the UN's international environment–economy accounting standard. When possible, we analyse both the approaches and data availability; weaknesses in the approaches and a lack of available data both present challenges for aligning measurement with the potential of transformational green economy concepts. Measurement informed by weak green economy approaches or that does not sufficiently embody the process of transformation risks steering green economy actions towards weaker visions. Studies across several disciplines note the relevance of the much-used phrase 'What gets measured, gets managed' (Barnett 2015; Bevan and Hood 2006; Heal 2012; Hood 2012). However, the complete, original quotation reads 'What gets measured gets managed – even when it's pointless to measure and manage it, and even if it harms the purpose of the organization to do so' (Drucker, as cited in Barnett 2015, 5). Performance measurement often has unintended consequences in public and private situations; these examples suggest that measurement with limited data and poorly chosen indicators can either corrupt the original intention behind the goals, or reflect political ideologies and their influence over societal goals. Bjørnholt and Larsen (2014, 407) concluded that 'the goal-setting and performance measurement processes are just as important for the outcome of public policy as the political process', informing our approach to consider the interactions of green economy concepts and measurement approaches.

OECD green growth monitoring framework

The OECD's green growth monitoring framework (OECD 2011) has been used by some nations to experiment with monitoring progress towards green growth (Czech Statistical Office 2011 2014; Destatis 2012; Slovak Republic 2014; Statistics Korea 2012; Statistics Netherlands 2011). Its 30 indicators cover sustainability and equity, environmental and resource productivity, natural assets, environmental quality of life, and economic opportunities and policy responses (OECD 2011). Not all of these indicators are currently measurable. The framework is adaptable; the indicators have been used to frame debates around standards of living by connecting this to the environment and green growth opportunities (GGKP 2013). The question remains: can it assess the interactions between economic, environmental and social factors, beyond presenting such information side by side? Difficulties arise when data for 'first choice' indicators are unavailable, or when a green growth national definition may ignore an issue (such as social inequality). This is problematic for the transformational green economy as 'substitute' indicators are lower in relevance and utility, and the framework's flexibility also permits countries to not measure important transformational issues such as inequality or environment–economy interactions. The OECD framework is also heavily reliant on GDP-based indicators.

A number of countries have produced reports using the OECD indicator framework (Czech Statistical Office 2011 2014; Destatis 2012; Slovak Republic 2014; Statistics Korea 2012; Statistics Netherlands 2011); 23 according to a recent report (OECD 2014). These acknowledge that data are not currently available for all the indicators. Statistics Korea, for example, report on 23 of the OECD indicators (Statistics Korea 2012). However, in several cases Statistics Korea uses 'proxies', whose relevance to green economy measurement is questionable: 'Annual rainfall per capita' and 'Contribution of aquaculture to fish production' are weak indicators of sustainability in freshwater and fish resources. It is difficult to agree with the statement that:

> Most indicators related to natural assets among OECD green growth indicators are not included … because natural asset indicators decisively governed by natural circumstances cannot ascertain the policy performance and the implementation level of green growth.
>
> (Choi 2014, 42)

Despite the 'transformational' aims of South Korea's green economy approach, it is uncertain whether such measurements can aid in delivering transformations. Weak links between policy performance measurement and the environment is unlikely to lead to transformational effects.

The Czech Republic's report includes coal reserves and cumulative coal mining (Czech Statistical Office 2011). No justification is given for using coal reserves as a green growth indicator, nor is any trend established on the sustainability of extraction. In the Netherlands report, indicators covering society and inclusivity are omitted (Statistics Netherlands 2011). While adoption by 23 countries by 2014 is impressive, these alterations mean that the framework's flexibility creates difficulties for international comparisons. The framework's limitations may reflect the inherent 'weakness' of the OECD green growth/green economy paradigm.

UNEP green economy indicators and policy-making

UNEP conducts significant work on incorporating green economy indicators into policy-making. Many

ISSN 2054-4049 doi: 10.1002/geo2.36

policy issues, such as the prevalence of water-borne diseases among rural farmers, have strong connections to environmental issues, requiring environmental as well as social and health policies (UNEP 2014b). UNEP highlights that well designed indicators benefit the entire policy process as each stage (from issue identification, to policy formulation, to monitoring and evaluation) requires different indicators. This issue-driven approach is practical, but requires sufficient data to correctly prioritise critical issues and assess policy impacts. It risks focusing heavily on short-term issues under resource constraints with the potential to miss spillover effects, affecting the ability of indicators produced to contribute to 'lesson learning' between countries. Timely, relevant and transparent information could contribute to the ability of indicators to influence cross-border policy learning. Policy learning is a complex, multi-tiered process that impacts state officials, policy networks and policy communities (Bennett and Howlett 1992), in ways that range from voluntary and collaborative to coercive (Shen 2014). As policy transfer opportunities move from 'hard' transfer between national policy-makers to 'soft' transfer in spaces of multi-level collaboration and networked governance (Benson 2009), greater transparency of indicators for policy-making will be important for effectively sharing positive (and negative) experiences.

Wealth Accounting and Valuation of Ecosystem Services Global Partnership

The World Bank leads the Wealth Accounting and Valuation of Ecosystem Services (WAVES) Global Partnership. Currently, 70 nations have signed up, of which eight are core implementing partners (WAVES Partnership 2014). It aims to develop internationally agreed methods for accounting for natural capital and ecosystem services, assist nations in adopting accounts and incorporating them into policy-making, and provide technical support for SEEA implementation. Holistic natural capital measurement is fundamental to green economy measurement; without the appropriate inclusion of the environment in decision-making, development has little hope of being sustainable. WAVES seeks to extend accounting methodologies beyond traded natural resources such as timber into harder-to-measure, non-marketed ecosystem services.

There is some progress in implementing national natural capital accounts**.** According to a WAVES Partnership report (2012), 24 countries have recognised natural capital accounting programmes. The accounts produced at this stage only partially represent the value of natural capital, even when countries have moved beyond pilot programmes. Many harder-to-measure areas are not covered; partial coverage of natural capital may skew policy decisions. The UK's natural capital accounts have begun to demonstrate the economic and societal value of natural capital (Office for National Statistics 2014, hereafter ONS). A GLOBE study (2013) examined accounts in eight countries and saw encouraging signs of progress across five different regions; however no country is advancing comprehensively in all areas. World Bank studies also show the importance of moving from pilot to full programmes in developing countries (WAVES Partnership 2012). This has more potential to contribute towards transformational approaches. However, it could entrench economic growth-based concepts or lead to unintended consequences if partial natural capital valuation is used in policy decisions.

UN System of Environmental-Economic Accounting

The UN Statistics Division has led to the development of the UN SEEA, now formally adopted (United Nations 2014b). Described as a 'multipurpose conceptual framework for understanding the interactions between the economy and the environment, and for describing stocks and changes in stocks of environmental assets' (United Nations 2014b, x), it builds on three previous 'Handbooks of national accounting' (United Nations 1993 2000; United Nations *et al.* 2003) and the 2012 white cover (European Commission *et al.* 2012). As an international standard, the SEEA is highly relevant to how the green economy will be measured. The SEEA assesses trends in natural resource use, the extent of emissions and discharges to the environment resulting from economic activity and the amount of economic activity undertaken for environmental purposes. This is, arguably, a narrow approach to measuring environment–economy interactions that may favour weak green economy concepts. Indicators can be derived from these accounts to better inform decision-making and more complete data collection may better inform transitions, but it may not correctly measure trade-offs or sufficiently inform decision-making for green economy transformations of socioeconomic systems.

There will be benefits if it is applied as an international statistical standard. But will this happen? And if the significant barriers are overcome, when will it happen? Policy targets have a 20-year horizon, but this measurement agenda may take a similar amount of time to produce results. Moreover, this does not confront the significant limitations to environmental–economic accounting for measuring social, as well as environmental, outcomes. For example, the SEEA's socio-demographic data (relating to employment and population) is significantly less comprehensive than UNEP and OECD approaches (United Nations 2014b).

ISSN 2054-4049 doi: 10.1002/geo2.36

Beyond the Central Framework, the SEEA also contains the SEEA Experimental Ecosystem Accounting and the SEEA Applications and Extensions (European Commission *et al.* 2013 2014). The former provides a synthesis of current knowledge on ecosystem accounting aligned with the SEEA, not a statistical standard. Applications and Extensions describes potential outputs for presenting or analysing data collected through the Central Framework. Both indicate future research directions, further examining the interactions between environment and economy. Future work may provide greater levels of insight for policy-makers. However, they may still be too limited to support the transformational aspects of the green economy, due to the rigidity of data collection.

Climate change adaptation is not covered by the SEEA Central Framework, raising questions of its appropriateness. It only notes 'that information on this activity may be of particular interest' (United Nations 2014b, 90). We argue that it should be included; impacts of climate change will have significant social impacts. Adaptation and climate risk management are especially important for green growth in Africa and Asia-Pacific (AfDB 2012; UNESCAP 2014). Several documents (the outcome document of Rio+20, and World Bank and UNEP reports) argue for 'inclusivity' in green economy approaches. Moreover, the United Nations Global Compact (UNGC), UNEP, Oxfam and World Resources Institute collaborated on *Adapting for a green economy*, which emphasises the close connection between businesses and communities for climate change adaptation and the green economy, with examples from mangrove forests to affordable drip irrigation (UNGC *et al*. 2011). Environmental expenditure measurement is not fulfilling its role, if it cannot fully measure the progress and opportunities of the green economy. Limited data collection may contribute to strengthening stability in existing systems to preserve them, not moving them to a new state, which is indicative of approaches to protect the status quo not foster transformative change (Pelling and Manuel-Navarrete 2011).

These approaches are still in their infancy and there are positive effects for better understanding environment–economy interactions, and designing and measuring better green economy policies. These approaches recognise the need to at least complement GDP, without embracing 'beyond GDP' discourses. However, given this inherent tendency towards 'weak' green economy management concepts in these measurement approaches, it is not certain that they will sufficiently advance a progressive measurement agenda for transformational green economy visions. Although perhaps the most difficult aspect, further progress on measuring environment–economy–society interactions is required, beyond presenting indicators side by side and developing partial measurements of natural capital. Approaches based on current measurement and data have the potential to entrench weak green economy visions and limit the transformative potential of the green economy.

Limitations of current economic measurement of the green economy

Previous reviews of this subject appear not to fully engage with the problems of economic measurement of the green economy. One important aspect of economic measurement not previously assessed is measuring the scale of the response to environmental and climate challenges; measuring the aggregate environmental impact of economic activities and using supply-side measurement to track the transformation of economies. Current efforts to monitor the green economy frequently extend to collecting data on 'traditional' environmental sectors (such as wastewater treatment).

It is important to assess the major attempts to measure the economic impact of the green economy frameworks and practices. As the GGKP (2013) notes, presenting balanced messages is key; many indicators focus on challenges or minimising risks, not identifying opportunities. The quality and coverage of 'opportunity' indicators is frequently poorer. To explore this need for balance and given the huge range of indicators required for green economy measurement, we will examine indicators of economic opportunities: due to weaknesses in implementation, as an example of wider challenges, and for their role in generating green economy policy adoption. More importantly, economic measurement has some potential to measure the green transformation of economies; how the composition of economic activities is changing and the dynamics of environment–economy–society interactions both need to be measured.

In 2009, Eurostat produced a reporting framework for EU countries for the Environmental Goods and Services Sector (EGSS), covering environmental protection and resource management activities (Eurostat 2009). It addresses the difficulty that standard national accounting methods neither account for environmental impact, nor a product's end purpose. It covers a narrow definition; 'goods and services to prevent, measure, control, limit, minimize or correct environmental damage and resource depletion' (Eurostat 2009, 19). Measuring the 'environmental sector' in this way does not necessarily align with more expansive and transformational green economy definitions reviewed previously, which are more inclusive of nature, ecosystem services and social aspects of a green economy. However, it has been adopted in the SEEA. EGSS is therefore positioned

ISSN 2054-4049 doi: 10.1002/geo2.36

to have a role in measuring green economy transitions, although it captures neither all aspects of the green economy nor its potential for creating new economic pathways or restructuring economic activity. Thus it should be critiqued.

EGSS provides a framework for supply-side data collection, which can provide a measurement of the economic response to environmental and natural resource challenges, and seeks consistency with existing frameworks and classification systems (European Commission *et al.* 2012; Eurostat 2002a 2002b 2008; United Nations 2008 2014b). Existing systems do not capture the true complexity and economic contribution of the green economy 'since it is not possible to identify and classify EGSS producers exhaustively using exclusively standard statistical classifications' (Eurostat 2009, 71). Therefore, its potential for measurement of a transformational green economy is already limited. If treated as a 'target', EGSS could lead to 'output distortion' (Hood 2012); government departments could focus on improving the measured performance of the narrowly defined EGSS, rather than structurally transforming the green economy.

However, Statistics Netherlands (2011) suggests that an increasing share of EGSS in employment and output indicates a transition to an economy that is more dedicated to reducing environmental and resource pressures. If defined in an internationally comparable way, it could permit country-by-country comparison, and assessment and dissemination of best practice. However, the framework is flexible enough that statistics agencies can use different methodologies to collect EGSS data; A UNEP report (2014a) highlights five different ways of compiling data and eight different types of data sources. This could affect comparability. Furthermore, significant variation exists in experience of applying the EGSS methodology across Europe; some countries use it to produce statistics (Czech Statistical Office 2011; Statistics Netherlands 2011; Statistik Austria 2014a 2014b 2014c 2014d), whereas others have produced feasibility reports (Livesey 2010) and experimental statistics (ONS 2015). The ONS report, and particularly its proxy methodologies for organic agriculture and forestry management, demonstrate the challenge in producing robust, comparable EGSS data; where the approach can be tailored to reflect available data (or estimates), rather than encouraging the measurement of what matters to green economy visions, its transformative potential is reduced.

The process involves the identification of the entire EGSS population as the first step, regrouping the activities under Standard Industry Classification (SIC) codes, because 'EGSS cannot be established *a priori* using standard statistical classifications' (Eurostat 2009, 71). For it to be used globally, significant data collection difficulties must be overcome. Data issues may prevent consistent measurement across countries being possible (Bishop and Brand 2013). The resources for conducting the required surveys may be too great for many national statistics offices. International comparison would be useful to compare performance of policies between countries. Such 'benchmarking' would be a first step towards identifying the policies that can contribute to green economy transformations.

A contradiction exists between the wider purpose of the policy visions and the narrowly defined sectors of reporting frameworks; this is problematic if we need to measure opportunities and transformations, not just 'clean-up' activities. As suggested in the performance measurement literature, the choice of performance goals and measurement can impact upon political and policy processes (Bjørnholt and Larsen 2014). Thus current measurement approaches can contribute to the tension between defining the green economy as part of the whole (a 'weak' approach that considers the green economy a 'lever' for economic growth) versus 'greening' (or transforming) the whole economy by addressing underlying structural issues in the economy.

Measurement using national statistics

The EGSS methodology seeks to measure a country's green economy performance with national statistics but, as we will show, this is challenging. Comparing the greening of the economies of different countries is an even greater challenge. National statistics are compiled using SIC codes, which do not record how something is made, (an important factor in how 'green' a product is), and thus do not record 'greenness'. Using data compiled with SIC codes therefore has limited potential for identifying the greening of economic activity, as 'the production of environmental goods and services cuts across the whole economy and will often only represent a fraction of an organization's output, being a secondary or ancillary activity' (Livesey 2010, 52).

Many studies have questioned the utility of SIC codes for research across a number of fields (Clarke 1989; Amit and Livnat 1990; Guenther and Rosman 1994; Kahle and Walking 1996; Fan and Lang 2000; Bhojraj *et al.* 2003; Jacobs and O'Neill 2003; Kile and Phillips 2009). Kile and Phillips's study (2009) highlighted the difficulties for emergent twenty-first century industries and technologies and the limitations of SIC codes are greater when attempting to partition high-tech firms. SIC codes were established in the 1930s when the focus of the US economy was manufacturing. Despite periodic updating, SIC codes often fail to provide classifications for services and the emerging industries of the twenty-first century (Kile and Phillips 2009). Moreover, SIC codes are product based, not process based, and reflect a focus limited to a firm's products and services, without consideration

ISSN 2054-4049 doi: 10.1002/geo2.36

of markets or methods to market them (Fan and Lang 2000). Firms may have some incentives to misreport their economic activities under the SIC system (Kile and Phillips 2009). Importantly, they will also ignore green economic activity of firms without an environmental activity as their primary purpose.

As outlined by Eurostat, for measurement of EGSS, activities recorded must satisfy the end purpose criterion; their primary objective should be environmental protection or resource management (Eurostat 2009). This is broad, but it will not capture all 'adapted goods'[1], supply chains that include goods and services with other 'non-green' uses, or goods and services directly from ecosystems and biodiversity.

There is a broader limitation to both economic measurement and indicators for the green economy; the social elements of UNEP and World Bank's green economy visions are particularly important for the legitimacy and global relevance of the green economy under the SDGs. Economic measurement should be supported by other indicators and types of feedback (such as non-quantitative assessments of governance, inclusion in policy processes and patterns of inequality) to ensure that the green economy can deliver transformations for inclusive societies and shared prosperity. Nevertheless, for economic measurement it is not enough to merely record environmental protection activities; this does not fully measure green economy transformations and entrenches weak visions of the green economy. Broader economic measurement is required as part of broader measurement overall, including non-quantitative assessments.

Data availability

For all aspects of green economy measurement, there are significant capacity and data constraints to overcome. However, data availability from official sources for economic measurement of the green economy causes some concerns. It demonstrates how data availability can affect the measurement of progress towards different green economy visions and entrench path dependency towards weaker green economy paradigms. Eurostat's EGSS has the broadest implementation, and thus serves as a good example. From the Eurostat statistics database, the most recent year for EGSS data is 2013 (Eurostat 2016). The most recently published report covers environmental protection expenditure only, up to 2013 (Eurostat 2015). There are few publically released Eurostat data that can be compared between countries with confidence; Table II demonstrates that for production value of total EGSS, only up to seven countries' data are available in any year. The calculation of the EU-28 aggregate figure must be questioned, given such limited underlying data. Evidence from various national contexts, such as Sweden, the UK, Poland and Canada,

Table II Eurostat EGSS data on environmental protection and resource management expenditure in the EU-28

	Total environmental protection and resource management activities (EGSS): production value (€ million)										
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
EU-28	393,439.00	428,661.00	478,579.00	520,582.00	570,514.00	552,467.00	615,753.00	678,864.00	689,113.00	697,456.00
Belgium	15,814.76	:	:	:	:	:	:	:	:	:
Bulgaria	:	:	:	:	:	:	:	900.80	1062.29	:
Germany	:	:	:	28,288.00	:	81,039.11	128,636.01	144,118.53	145,948.09	:
France	:	:	:	:	47,014.00	63,730.00	56,947.00	76,437.00	:	:
Lithuania	:	:	:	:	:	:	668.38	1541.06	:	:
Luxembourg	:	:	:	:	1723.79	1405.22	1599.06	1725.56	1721.51	:
Netherlands	:	:	:	:	:	:	:	:	33,182.00	:
Austria	:	:	:	:	31,047.53	30,844.37	31,618.49	32,622.54	36,000.98	:
Poland	:	:	:	18,608.06	:	:	:	:	:	:
Romania	:	8448.80	9790.46	6344.21	7356.60	5741.56	6682.13	9246.00	9189.86	:

':' indicates missing values.

ISSN 2054-4049 doi: 10.1002/geo2.36

shows that these 'traditional' approaches require extensive research, including surveys outside of existing national statistics collection (Brolinson *et al.* 2006; Statistics Canada 2006; Central Statistical Office of Poland 2008; Livesey 2010). Current Eurostat data are evidence that this is not happening.

By comparison, the US Department of Commerce estimated the US green economy using narrow and broad measures, where the primary purpose criterion must be fulfilled in the former (US Department of Commerce 2010a). However, the survey was discontinued, last reporting 2011 data in 2013 (Barbier 2014). A major difference was the inclusion of all forms of mass transportation (US Department of Commerce 2010b). In addition, other countries (such as the UK and Germany) also collect data with different sectoral definitions ('the Low Carbon Economy' and 'Green Tech') that are not aligned with EGSS (Department for Business Innovation & Skills 2015, hereafter BIS; Federal Ministry for the Environment 2014). Along with different discourses identified in the Asia-Pacific, this highlights the challenge in generating internationally comparable measurement. We conclude that global implementation of EGSS (and the SEEA) will be difficult, due to different national accounting practices and national capacity constraints, its potential lack of universal relevance notwithstanding.

Overall, from this evidence we can identify two areas of improvement required for measurement of green economy transformations: better economic measurement of green economy transformations and improved measurement of broader environment–society–economy interactions. Taking into consideration the need to move beyond GDP previously discussed, there are therefore three major challenges and a fourth that connects to all three (Figure 4): the need for alternative measurement approaches, which is exemplified by the difficulty of using national statistics for economic measurement. These four areas represent a pathway towards a realigned measurement approach for the *transformational green economy*: to better measure whether transformations are taking place, where and how they are occurring, and how policies can be better designed to deliver transformational change.

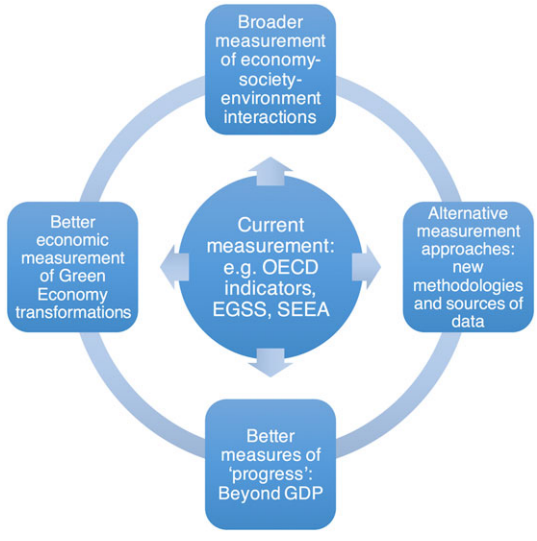

Figure 4 Four key recommendations for improved, expanded measurement of green economy transformations

Alternative measurement approaches

Alternative measurement approaches should be explored, so that the green economy has the indicators that better reflect progress towards transformation of economies and so that indicator choice and data availability alone do not continue to justify economic growth-based green economy visions. From the analysis above, we suggest that the data required should cover a broader range of issues, and be produced more quickly and more cheaply. Incorporating alternative measurement approaches for the green economy is our fourth key recommendation, shown in Figure 4; we will discuss three examples that could contribute towards the recommendations outlined previously for better measurement of green economy transformations.

Composite approaches

Combining different measurements into a single value or set of values is attractive for simplifying complex realities. Composite approaches and indices have advantages for presenting broader pictures of progress, with benefits for communicating to a broader audience the interactions in a complex system and the state of transformational change. They have the potential to contribute to our recommendations of improving broader measurement of economy–society–environment interactions and offering better measures of societal progress to move beyond GDP. However, composite approaches must balance simplicity with detail; a methodology for selecting indicators needs to consider more than just statistical criteria (Fukuda-Parr *et al.* 2014) as it will reflect assumptions about the interactions between indicators in an index and between indicators and the phenomena under measurement.

The Genuine Progress Indicator uses 26 economic, environmental and social indicators to weigh up the positive and negatives of economic growth (Costanza *et al.* 2004). It includes indicators that measure environmental costs, inequality arising from consumption and social factors that affect quality of life. It is an imperfect measure of wellbeing but

ISSN 2054-4049 doi: 10.1002/geo2.36

demonstrates important trends. Presenting indicators side by side can create difficulties of interpretation, as it is difficult to compare measures across different sectors that are incommensurable.

Their simplicity makes composite indices a powerful means for communication. However, they 'hide' detail by expressing progress through one number, require weighting and thus valuing of sub-indicators, and no approach currently developed captures all elements of sustainable development (Statistics Netherlands 2015). For example, the Inclusive Wealth Index seeks to provide countries with a realistic understanding of their wealth and its long-term sustainability. It is a valuable effort to combat the 'narrowness' of national accounts (by measuring natural, human and health capital) and assess long-term progress (UN University–International Human Dimensions Programme and UNEP 2014). The criticism of the index highlights the difficulty in creating composite indices using currently available data and in the value judgements required; Thiry and Roman (2014) question the underlying utilitarian welfare function, its strong reliance on shadow prices and monetary valuations, and a narrow productivist approach to areas like human or health capital.

Other composite approaches intended as better measures of progress include the Index of Sustainable Welfare, the Sustainable Net Benefit Index, the Better Life Index and the New Economic Foundation's 'Five Headline Indicators of National Success'. While surveys have suggested that composite indices have benefits for both public communication and policy-making (Böhringer and Jochem 2007), their benefits as a communication tool appear to be stronger. The GGKP (2015) questioned the use of composite indices in developing countries, noting that they are frequently subjective and *ad hoc*, and more research is required into how they are constructed. Such problems amplify the difficulties caused by limited data availability.

Finally, the Ecological Footprint (EF) approach has been applied across a wide variety of contexts and scales. It is well established for assessing the scale of an economy's environmental impact. A powerful use of EF studies is to assess the international distribution of inequalities of ecological footprints (Teixidó-Figueras and Duro 2015). As with indices, EF approaches are important for communication but may have a limited policy role and cannot cover all relevant issues at once, remaining most useful when used alongside other approaches (Wiedmann and Barrett 2010).

Earth Observation data

Earth Observation (EO) has huge potential for global, cost-effective monitoring in many areas of green economy measurement. EO can provide huge quantities of relevant data quickly and cheaply to decision-makers and policy-makers; it therefore contributes towards our recommendation of improving measurement of economy–society–environment interactions by providing more comprehensive and cheaper inputs of data. Remote sensing technologies are constantly improving but another major development has been increasing data availability; NASA and the US Geological Survey made 40 years of Landsat archives freely accessible in 2008, the European Space Agency gives open access to data from Sentinel satellites and the Group on Earth Observations (GEO) led the Global Earth Observation System of Systems (GEOSS) project to integrate thousands of different EO technologies into a comprehensive, global system (Stone 2010).

EO data can aid the green economy and SDG measurement agendas in 'traditional' earth system-related applications such as forest cover (Da Ponte *et al.* 2015), disaster risk management (Briggs and Ward 2012) and wetlands (Jones *et al.* 2009), and 'social' applications such as public health (Weng *et al.* 2013) and sustainable urban development planning (Musakwa and Van Niekerk 2014). The growing availability of data, continuing technological progress and commitment to EO from organisations like the GEO and the Global Partnership for Sustainable Development Data (2015) mean that EO could have a significant role in measuring green economy transformations.

Transactional data

Correctly measuring the economic scale and impact of green economy activities (not only environmental 'clean-up' activities) can measure the opportunities of green economy transformations. The size and location of these opportunities are important signals to policy-makers and businesses to accelerate this transition. Within the SEEA, the only section that explicitly relates to green economy opportunities is EGSS. Within the OECD framework, there are several measures (EGSS, green R&D, green patents and environmentally related innovation) (OECD 2014). Our analysis concluded that EGSS neither accurately reflect the scale of green economy opportunities nor track key green economy transitions. Other OECD indicators do not measure opportunities sufficiently and only partially track policy responses.

Due to difficulties in measuring EGSS, between 2007 and 2013 BIS used the Low Carbon Environmental Goods and Services (LCEGS) dataset to monitor the 'low carbon economy' and the environmental sector in the UK. The most recent report, covering 2011/12, was released in July 2013 (BIS 2013). The underlying data were produced by kMatrix. The data acquisition and analysis methodology, outlined in several studies (Georgeson

ISSN 2054-4049 doi: 10.1002/geo2.36

et al. 2016; Maslin and Poessinouw 2012), is based on a system originally developed at Harvard for triangulating transactional and operational business data to estimate economic values for industries when government statistics were not available (Jaikumar 1986). Originally developed to track industrial, technological and market changes, it records *how* goods are made. It is more powerful than SIC data collection to define a product's end purpose, by drawing on data from procurement, logistics, insurance and other sources, not just sales data. BIS used LCEGS as a proxy for statistics, while changes to industry classifications were considered. The data can be broken out at sectoral level; the 'greenness' of sectors, industries and countries can be compared, providing a means of exploring green economy transformations across different scales and the influence of different national and sub-national contexts and priorities. Therefore, transactional data have the potential to contribute significantly to our recommendation of better economic measurement of green economy transformations.

Conclusion

The green economy is an important concept at multiple levels of governance. This was first examined by Pearce *et al*. (1989) and continued through the 'Green New Deals' and progress at Rio+20. It is widely used in national policy frameworks in countries as diverse as the UK and Sierra Leone. However, tensions still exist between competing discourses and actors. Green economy definitions are broad, requiring broader approaches for more effective measurement, including broader definitions for economic measurement than currently used.

This review has identified four key recommendations for improving measurement of green economy transformations. These are:

- better measures of 'progress' beyond GDP;
- broader measurement of economy–society–environment interactions;
- better economic measurement of green economy transformations;
- alternative measurement approaches: new methodologies and sources of data.

It is acknowledged, even by those who advance 'weak' green economy visions that better measures of progress and development, analysing the quality and composition of growth (OECD 2011) (and whether growth is positive), are required. Accurate measurement of economic activity is important for sound decision-making, including measuring the composition and growth of the green economy. We need to appreciate the key relationships between the flow of national income and a nation's stock of wealth, including natural and social capital (Nellis and Parker 2004), and the green economy needs ways to measure the transformation of economies.

Recording and reporting green economy activities is essential so they can be encouraged and, if appropriate, subsidised. Some evidence suggests that the global situation improved under the MDGs because these indicators of development and poverty reduction were measured (Sachs 2012), although not all targets will be met and there is evidence of a number of unintended consequences from MDG measurement choices (Fukuda-Parr 2014). Clear green economy measurement between countries would force governments to take note, and this may cause the 'greenness' of economies to improve. This may help to define a role for green economy in the post-2015 agenda: to alleviate inherent conflicts when governments attempt to achieve different SDG targets and COP 21 commitments, and their own national priorities.

Developing measurement of interactions between the environment and economy is also vital. There is significant international effort to coordinate and support national-level action, and progress has been made. Across all areas examined, challenges remain: for example, there are significant limitations of national accounting for the green economy, and measurement frameworks must account for different national contexts and data collection difficulties. Alternative approaches may be able to provide data more cheaply and more quickly, supporting national statistics agencies and filling gaps in data collection.

Finally, metrics that go beyond GDP are urgently required; there will be a real impact on delivering the green economy without them. To understand and to accelerate global transitions to the green economy and to deliver genuine green economy transformations, we must assess what useful metrics can be measured now and in the future.

Acknowledgements

The authors would like to thank the anonymous reviewers for their feedback, and the editors of this journal for their supportive and constructive editorial assistance. The authors would like to thank the following organisations for providing funding support: the Economic and Social Research Council and the Natural Environment Research Council (grant number ES/J500185/1), and the Royal Society.

Note

1 Adapted goods are defined by Eurostat as goods that are 'less polluting or more resource-efficient than equivalent

ISSN 2054-4049 doi: 10.1002/geo2.36

normal products which furnish a similar utility. Their primary use is not one of environmental protection or resource management' (Eurostat 2009).

References

Aberbach J D and Christensen T 2001 Radical reform in New Zealand: crisis, windows of opportunity, and rational actors *Public Administration* 79 403–22

Acemoglu D, Aghion P, Bursztyn L and Hemous D 2012 The environment and directed technical change *American Economic Review* 102 131–66

African Development Bank (AfDB) 2012 *Facilitating green growth in Africa: perspectives from the African Development Bank* (www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Facilitating_Green_Growth_in_Africa__Perspectives_from_the_African_Development_Bank_June_2012.pdf) Accessed 24 July 2015

African Development Bank (AfDB) 2014 *Green growth Sierra Leone: investing in environmentally sound economic growth* African Development Bank, Tunis (www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Sierra_Leone_-_Investing_in_Environmentally_Sound_Economic_Growth.pdf) Accessed 27 June 2016

Amit R and Livnat J 1990 Grouping of conglomerates by their segments' economic attributes: towards a more meaningful ratio analysis *Journal of Business Finance & Accounting* 17 85–100

Attaran A 2005 An immeasurable crisis? A criticism of the millennium development goals and why they cannot be measured *PLoS Med* 2 955–61

Bailey I and Caprotti F 2014 The green economy: functional domains and theoretical directions of enquiry *Environment and Planning A* 46 1797–813

Barbier E B 2011 The policy challenges for green economy and sustainable economic development *Natural Resources Forum* 35 233–45

Barbier E B 2013 The green economy post Rio+20 *Science* 33 887–8

Barbier E B 2014 *Whither the green economy?* (http://triplecrisis.com/whither-the-green-economy/) Accessed 13 July 2015

Barbier E B 2015 Policies to promote green economy innovation in East Asia and North America *STI Policy Review* 6 54–69

Barnett P 2015 If what gets measured gets managed, measuring the wrong thing matters *Corporate Finance Review* Jan/Feb 5–10

Bennett C J and Howlett M 1992 The lessons of learning: reconciling theories of policy learning and policy change *Policy Sciences* 25 275–94

Benson D 2009 *Review article: Constraints on policy transfer CSERGE working paper EDM*, No 09-13 Centre for Social and Economic Research on the Global Environment, Norwich

Bernstein S 2013 Rio+20: sustainable development in a time of multilateral decline *Global Environmental Politics* 13 12–21

Bevan G and Hood C 2006 What's measured is what matters: targets and gaming in the English public health care system *Public Administration* 84 517–38

Bhojraj S, Lee C M C and Oler D K 2003 What's my line? A comparison of industry classification schemes for capital market research *Journal of Accounting Research* 41 745–74

Biermann F, Abbott K, Andresen S, Bäckstrand K, Bernstein S, Betsill M M, Bulkeley H, Cashore B, Clapp J, Folke C, Gupta A, Gupta J, Haas P M, Jordan A, Kanie N, Kluvánková-Oravská T, Lebel L, Liverman D, Meadowcroft J, Mitchell R B, Newell P, Oberthür S, Olsson L, Pattberg P, Sánchez-Rodríguez R, Schroeder H, Underdal A, Camargo Vieira S, Vogel C, Young O R, Brock A and Zondervan R 2012 Navigating the Anthropocene: improving Earth system governance *Science* 335 1306–7

Bina O and La Camera F 2011 Promise and shortcomings of a green turn in recent policy responses to the 'double crisis' *Ecological Economics* 70 2308–16

Bishop P and Brand S 2013 Measuring the low carbon economy at the local level: a hybrid approach *Local Economy* 28 416–28

Bjørnholt B and Larsen F 2014 The politics of performance measurement: 'Evaluation use as mediator for politics' *Evaluation* 20 400–11

Bloomberg New Energy Finance (BNEF) 2016a *Clean energy investment in 2016 undershoots last year's record* Bloomberg, London and New York

Bloomberg New Energy Finance (BNEF) 2016b *New energy outlook 2016* Bloomberg, New York

Böhringer C and Jochem P E P 2007 Measuring the immeasurable – a survey of sustainability indices *Ecological Economics* 63 1–8

Borel-Saladin J M and Turok I N 2013 The green economy: incremental change or transformation? *Environmental Policy and Governance* 23 209–20

Bowen A and Fankhauser S 2011 The green growth narrative: paradigm shift or just spin? *Global Environmental Change* 21 1157–9

Bowen A, Fankhauser S, Stern N and Zenghelis D 2009 *An outline of the case for a 'green' stimulus* Grantham Research Institute on Climate Change and the Environment, London (http://eprints.lse.ac.uk/24345/1/An_outline_of_the_case_for_a_green_stimulus.pdf) Accessed 27 June 2016

Brand U 2012 Green economy – the next oxymoron? No lessons learned from failures of implementing sustainable development *GAIA - Ecological Perspectives for Science and Society* 21 28–32

Briggs S A and Ward S 2012 Earth observation from satellites: supporting the outcomes of UNCSD (Rio+20) *Environmental Policy and Law* 42 357–64

Brockington D 2012 A radically conservative vision? The challenge of UNEP's towards a green economy *Development and Change* 43 409–22

Brolinson H, Cederlund M and Eberhardson M 2006 *Environmental goods and services sector in Sweden 2002–2005* Statistics Sweden, Stockholm (www.scb.se/statistik/_publikationer/MI1301_2005A01_BR_MIFT0702.pdf) Accessed 27 June 2016

Brown E, Cloke J, Gent D, Johnson P H and Hill C 2014 Green growth or ecological commodification: debating the green economy in the global South *Geografiska Annaler: Series B, Human Geography* 96 245–59

ISSN 2054-4049 doi: 10.1002/geo2.36

Caprotti F 2010 From finance to green technology activist states, geopolitical finance and hybrid neoliberalism in **Lagoarde-Segot T** ed *After the crisis: rethinking finance* Nova Science Publishers, New York 81–100

Caprotti F and Bailey I 2014 Making sense of the green economy *Geografiska Annaler: Series B, Human Geography* 96 195–200

Caprotti F, Cowley R, Datta A, Castán Broto V, Gao E, Georgeson L, Herrick C, Odendaal N and Joss S 2017 The new urban agenda: key opportunities and challenges for policy and practice *Urban Research & Practice*. https://doi.org/10.1080/17535069.2016.1275618

Cato M S 2009 *Green economics, an introduction to theory, policy and practice* Earthscan, London

Central Statistical Office of Poland 2008 *Environmental goods and services sector: final report from pilot project conducted under Eurostat-CSO agreement no. 71401.2007.014-2007.496* Central Statistical Office of Poland, Warsaw (https://circabc.europa.eu/sd/d/c5723487-5a9b-4196-aea4-3ae4361daf61/PL 496 EGSS.pdf) Accessed 27 June 2016

Choi S D 2014 *Green growth in action: the green growth movement in the Republic of Korea: option or necessity?* Korea Green Growth Partnership, Washington DC

Clark H 2013 What does Rio+20 mean for sustainable development? *Development* 56 16–23

Clarke R N 1989 SICs as delineators of economic markets *The Journal of Business* 62 17–31

Clémençon R 2012 Welcome to the Anthropocene: Rio+20 and the meaning of sustainable development *The Journal of Environment & Development* 21 311–38

Costanza R, Erickson J, Fligger K, Adams A, Adams C, Ben A, Balter S, Fisher B, Hike J, Kelly J, Kerr T, McCauley M, Montone K, Rauch M, Schmiedeskamp K, Saxton D, Sparacino L, Tusinski W and Williams L 2004 Estimates of the Genuine Progress Indicator (GPI) for Vermont, Chittenden County and Burlington, from 1950 to 2000 *Ecological Economics* 51 139–55

Czech Statistical Office 2011 *Green growth in the Czech Republic: selected indicators* Czech Statistical Office, Prague (www.czso.cz/csu/czso/green-growth-in-the-czech-republic-2010-a591berarf) Accessed 27 June 2016

Czech Statistical Office 2014 *Green growth in the Czech Republic: selected indicators 2013* Czech Statistical Office, Prague (www.czso.cz/csu/czso/green-growth-in-the-czech-republic-selected-indicators-2013-whvt3a3q88) Accessed 28 June 2016

Damon M and Sterner T 2012 Policy instruments for sustainable development at Rio+20 *The Journal of Environment & Development* 21 143–51

Da Ponte E, Fleckenstein M, Leinenkugel P, Parker A, Oppelt N and Kuenzer C 2015 Tropical forest cover dynamics for Latin America using Earth observation data: a review covering the continental, regional, and local scale *International Journal of Remote Sensing* 36 3196–242

Davies A R 2013 Cleantech clusters: transformational assemblages for a just, green economy or just business as usual? *Global Environmental Change* 23 1285–95

Death C 2015 Four discourses of the green economy in the global South *Third World Quarterly* 36 2207–24

Department for Business Innovation & Skills (BIS) 2013 *Low carbon and environmental goods and services (LCEGS): report for 2011/12* Department for Business Innovation & Skills, London

Department for Business Innovation & Skills (BIS) 2015 *The size and performance of the UK low carbon economy: report for 2010–2013* Department for Business Innovation & Skills, London

Destatis 2012 *Test of the OECD set of green growth indicators in Germany* Statistisches Bundesamt, Wiesbaden (www.destatis.de/EN/Publications/Specialized/EnvironmentalEconomicAccounting/Sustainability/TestOECDGreenGrowth5850016129004.html) Accessed 28 June 2016

European Commission 2010 *Europe 2020: a strategy for smart, sustainable and inclusive growth* European Commission, Brussels (http://ec.europa.eu/europe2020/index_en.htm) Accessed 24 June 2016

European Commission, Food and Agriculture Organization, International Monetary Fund, Organisation for Economic Co-operation & Development, United Nations and World Bank 2012 *System of environmental-economic accounting central framework* Published online by UN Statistics Division. (https://unstats.un.org/unsd/envaccounting/White_cover.pdf) Accessed 16 March 2016

European Commission, Food and Agriculture Organization, Organisation for Economic Co-operation and Development, United Nations and World Bank 2014 *System of environmental-economic accounting 2012: applications and extensions* Published online by UN Stats (https://unstats.un.org/unsd/envaccounting/ae_white_cover.pdf) Accessed 17 March 2016

European Commission, Organisation for Economic Co-operation & Development, United Nations and World Bank 2013 *System of environmental-economic accounting 2012: experimental ecosystem accounting* Published online by UN Stats (https://unstats.un.org/unsd/envaccounting/eea_white_cover.pdf) Accessed 17 March 2016

Eurostat 2002a *SERIEE: environmental protection expenditure accounts: compilation guide* Eurostat, Luxemburg

Eurostat 2002b *SERIEE: European system for the collection of economic information on the environment – 1994 version* Eurostat, Luxembourg

Eurostat 2008 *NACE Rev. 2: statistical classification of economic activities in the European Community* Eurostat, Luxembourg

Eurostat 2009 *The environmental goods and services sector: a data collection handbook* Eurostat, Luxembourg

Eurostat 2015 *Government expenditure on environmental protection Eurostat: statistics explained* (http://ec.europa.eu/eurostat/statistics-explained/index.php/Government_expenditure_on_environmental_protection) Accessed 19 February 2016

Eurostat 2016 *Production, value added and exports in the environmental goods and services sector* (http://ec.europa.eu/eurostat/web/environment/environmental-goods-and-services-sector/database) Accessed 17 March 2016

Evans S and Yeo S 2015 *Analysis: the final Paris climate deal, Carbon Brief* (www.carbonbrief.org/analysis-the-final-paris-climate-deal) Accessed 16 February 2016

Fan J P H and Lang L H P 2000 The measurement of relatedness: an application to corporate diversification *The Journal of Business* 73 629–60

Federal Ministry for the Environment 2014 *GreenTech made in Germany 4.0* Berlin

Ferguson P 2014 The green economy agenda: business as usual or transformational discourse? *Environmental Politics* 24 17–37

ISSN 2054-4049 doi: 10.1002/geo2.36

Fioramonti L 2014 The world's most powerful number: an assessment of 80 years of GDP ideology *Anthropology Today* 30 16–19

Fukuda-Parr S 2014 Global goals as a policy tool: intended and unintended consequences *Journal of Human Development and Capabilities* 15 118–31

Fukuda-Parr S, Yamin A E and Greenstein J 2014 The power of numbers: a critical review of millennium development goal targets for human development and human rights *Journal of Human Development and Capabilities* 15 105–17

Georgeson L and Maslin M 2014 *First goal of UN sustainability targets should be to not conflict with each other The Conversation* (www.theconversation.com/first-goal-of-un-sustainability-targets-should-be-to-not-conflict-with-each-other-32577) Accessed 24 July 2015

Georgeson L, Maslin M, Poessinouw M and Howard S 2016 Adaptation responses to climate change differ between global megacities *Nature Climate Change* 6 584–8

Global Green Growth Institute (GGGI) 2014 *GGGI Strategic Plan 2015–2020: accelerating the transition to a new model of growth* Global Green Growth Institute (http://gggi.org/wp-content/uploads/2012/10/gggi_strategic_plan-2015_final_web1.pdf) Accessed 24 June 2016

Global Partnership for Sustainable Development Data 2015 *Harnessing the data revolution to achieve the global goals for sustainable development data for 2030* (www.data4sdgs.org/historic-launch-press-release/) Accessed 15 February 2016

GLOBE 2013 *The GLOBE natural capital legislation study* Global Legislator's Organisation, London

Green Growth Knowledge Platform (GGKP) 2013 *Moving towards a common approach on green growth indicators: Green Growth Knowledge Platform scoping paper* Green Growth Knowledge Platform, Geneva

Green Growth Knowledge Platform (GGKP) 2015 *Measuring environmental action and economic performance in developing countries* UNEP, Nairobi

Guenther D A and Rosman A J 1994 Differences between COMPUSTAT and CRSP SIC codes and related effects on research *Journal of Accounting & Economics* 18 115–28

Gupta J and Wong K Y 2014 China's evolving development dilemma in the context of the North–South climate governance debate *Perspectives on Global Development and Technology* 13 699–727

Halle M 2012 *Life after Rio: a commentary by Mark Halle, IISD* (https://www.iisd.org/sites/default/files/publications/com_life_after_rio.pdf) Accessed 15 February 2016

Hare B, Schaeffer M, Lindberg M, Höhne N, Fekete H, Jeffrey L, Gütschow J, Sferra F and Rocha M 2014 *Policy brief: Below 2°C or 1.5°C depends on rapid action from both Annex I and Non-Annex I countries* Climate Action Tracker (http://climateactiontracker.org/assets/publications/briefing_papers/CAT_Bonn_policy_update_jun2014-final_revised.pdf) Accessed 18 March 2016

Heal G 2012 Reflections – defining and measuring sustainability *Review of Environmental Economics and Policy* 6 147–63

HM Government 2011 *Enabling the transition to a green economy: government and business working together* HM Government, London

Hood C 2012 Public management by numbers as a performance-enhanced drug: two hypotheses *Public Administration Review* 71 S85–S92

Intergovernmental Panel on Climate Change (IPCC) 2007 *Climate change 2007: synthesis report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* Intergovernmental Panel on Climate Change, Geneva

International Energy Agency (IEA) 2007 *World energy outlook 2007* International Energy Agency, Paris

International Energy Agency (IEA) 2012 *World energy outlook 2012* International Energy Agency, Paris

Jackson T and Victor P 2011 Productivity and work in the 'green economy' *Environmental Innovation and Societal Transitions* 1 101–8

Jacobs G and O'Neill C 2003 On the reliability (or otherwise) of SIC codes *European Business Review* 15 164–9

Jaikumar R 1986 Postindustrial manufacturing *Harvard Business Review* 64 69–76

Jänicke M 2012 'Green growth': from a growing eco-industry to economic sustainability *Energy Policy* 48 13–21

Jones K, Lanthier Y, van der Voet P, van Valkengoed E, Taylor D and Fernández-Prieto D 2009 Monitoring and assessment of wetlands using Earth Observation: the GlobWetland project *Journal of Environmental Management* 90 2154–69

Kahle K M and Walking R A 1996 The impact of industry classifications on financial research *The Journal of Financial and Quantitative Analysis* 31 309–35

Kamp-Roelands N 2013 *Private sector initiatives on measuring and reporting on green growth* OECD Publishing, Paris

Kile C O and Phillips M E 2009 Using industry classification codes to sample high-technology firms: analysis and recommendations *Journal of Accounting, Auditing & Finance* 24 35–58

Livesey D 2010 Measuring the environmental goods and services sector *Economic and Labour Market Review* December 45–58

Lorek S and Spangenberg J H 2014 Sustainable consumption within a sustainable economy – beyond green growth and green economies *Journal of Cleaner Production* 63 33–44

Martinelli A and Midttun A 2012 Introduction: towards green growth and multilevel governance *Energy Policy* 48 1–4

Maslin M and Poessinouw M 2012 Emergence of the carbon-market intelligence sector *Nature Climate Change* 2 300–2

McAfee K 2016 Green economy and carbon markets for conservation and development: a critical view *International Environmental Agreements* 16 333–53

Meadowcroft J 2012 Greening the state in **Steinberg P F and Van De Veer S D** eds *Comparative environmental politics: theory, practice, and prospects* MIT Press, Cambridge, MA 63–87

Morrow K 2012 Rio+20, the green economy and re-orienting sustainable development *Environmental Law Review* 14 279–97

Musakwa W and Van Niekerk A 2014 Monitoring sustainable urban development using built-up area indicators: a case study of Stellenbosch, South Africa *Environment, Development and Sustainability* 17 547–66

Nellis J G and Parker D 2004 *Principles of macroeconomics* Pearson, London

Office for National Statistics 2014 *UK natural capital – pre-release access, initial and partial monetary estimates* Office for National Statistics, London

ISSN 2054-4049 doi: 10.1002/geo2.36

Office for National Statistics 2015 *UK Environmental Goods and Services Sector (EGSS): 2010–2012* Office for National Statistics, London

Omilola B 2014 *Inclusive green growth in Africa: rationale challenges and opportunities* United Nations Development Programme, Pretoria

Organisation for Economic Co-operation & Development (OECD) 2011 *Towards green growth: monitoring progress: OECD indicators* OECD Publishing, Paris

Organisation for Economic Co-operation & Development (OECD) 2014 *OECD green growth studies: green growth indicators 2014* OECD Publishing, Paris

Pearce D W, Markandya A and Barbier E B 1989 *Blueprint for a green economy* Earthscan, London

Pelling M and Manuel-Navarrete D 2011 From resilience to transformation: the adaptive cycle in two Mexican urban centers *Ecology and Society* 16 1–11

Pelling M, O'Brien K and Matyas D 2014 Adaptation and transformation *Climatic Change* 133 113–27

Powers A 2012 The Rio+20 process: forward movement for the environment? *Transnational Environmental Law* 1 403–12

Republic of Rwanda 2011 *Green growth and climate resilience: national strategy for climate change and low carbon development* Republic of Rwanda, Kigali, Rwanda

Sachs J D 2012 From millennium development goals to sustainable development goals *The Lancet* 379 2206–11

Samans R 2013 *Green growth and the post-2015 development agenda: an issue paper for the United Nations high-level panel of eminent persons* Global Green Growth Institute, Seoul

Satterthwaite D 2003 The Millennium Development Goals and urban poverty reduction: great expectations and nonsense statistics *Environment and Urbanization* 15 181–90

Schmalensee R 2012 From 'green growth' to sound policies: an overview *Energy Economics* 34 S2–S6

Shen G C 2014 Cross-national diffusion of mental health policy *International Journal of Health Policy and Management* 3 269–82

Sierra K 2012 *Twenty years later: will green growth be the game changer needed for sustainable development?* (www.brookings.edu/~/media/research/files/reports/2012/6/rio20/rio20_sierra.pdf) Accessed 6 March 2017

Slovak Republic 2014 *Information portal on the environment: green growth indicators* (www1.enviroportal.sk/indikatory/schema.php?schema=124) Accessed 25 July 2015

Smith P 1995 On the unintended consequences of publishing performance data in the public sector *International Journal of Public Administration* 18 277–310

Sonnenschein J and Mundaca L 2015 Decarbonization under green growth strategies? The case of South Korea *Journal of Cleaner Production* 123 180–93

Statistics Canada 2006 *Concepts, sources and methods of the Canadian System of Environmental and Resource Accounts* Statistics Canada, Ottawa

Statistics Korea 2012 *Korea's green growth: based on OECD green growth indicators* Statistics Korea, Seoul

Statistics Netherlands 2011 *Green growth in the Netherlands* Statistics Netherlands, The Hague

Statistics Netherlands 2015 *Why a set of sustainability indicators, and not a composite indicator?* (www.cbs.nl/en-GB/menu/themas/dossiers/duurzaamheid/faq/specifiek/2011-why-a-set-of-sustainability-indicators-pol.htm) Accessed 20 July 2015

Statistik Austria 2014a *Environmental goods and services sector 2008 to 2012 with estimation of trade* Statistik Austria, Vienna

Statistik Austria 2014c *Environmental output and employment 2008 to 2012, goods, technologies and services* Statistik Austria, Vienna

Statistik Austria 2014b *Environmental output and employment 2008 to 2012, management of energy resources* Statistik Austria, Vienna

Statistik Austria 2014d *Environmental output and employment 2008–2012, economic sectors* Statistik Austria, Vienna

Stepping K M K and Stoever J 2014 *Measuring green growth: why standardisation is (sometimes) not desirable* German Development Institute, Bonn, Germany

Stern N 2006 *Stern review on the economics of climate change (pre-publication edition). Executive summary* HM Treasury, London (http://webarchive.nationalarchives.gov.uk/20130129110402/http://www.hm-treasury.gov.uk/sternreview_summary.htm) Accessed 7 June 2016

Stern N 2014 *Growth, climate and collaboration: towards agreement in Paris 2015* Grantham Research Institute on Climate Change and the Environment, London (www.lse.ac.uk/GranthamInstitute/publication/growth-climate-and-collaboration-towards-agreement-in-paris-2015/) Accessed 16 June 2016

Stevens C and Kanie N 2016 The transformative potential of the Sustainable Development Goals (SDGs) *International Environmental Agreements* 161 393–6

Stiglitz J E, Sen A and Fitoussi J-P 2009 *Report by the Commission on the Measurement of Economic Performance and Social Progress* Commission on the Measurement of Economic Performance and Social Progress, Paris

Stone R 2010 Earth-Observation Summit endorses global data sharing *Science* 330 902

Teixidó-Figueras J and Duro J A 2015 International ecological footprint inequality: a methodological review and some results *Environmental and Resource Economics* 60 607–31

ten Brink P, Mazza L, Badura T, Kettunen M and Withana S 2012 *Nature and its role in the transition to a green economy* The Economics of Ecosystems & Biodiversity and the Institute for European Environmental Policy, Geneva and London

Thiry G and Roman P 2014 *The Inclusive Wealth Index. A sustainability indicator, really?* FMSH-WP-2014-71 Collège d'études mondiales, Paris (https://halshs.archives-ouvertes.fr/halshs-01011250/) Accessed 7 June 2016

United Nations 1993 *Integrated environmental and economic accounting: interim version* United Nations, New York

United Nations 2000 *Integrated environmental and economic accounting: an operational manual* United Nations, New York

United Nations 2008 *International Standard Industrial Classification of all Economic Activities (ISIC) Rev. 4* United Nations, New York

United Nations 2014a *Open working group proposal for Sustainable Development Goals* United Nations, New York (https://sustainabledevelopment.un.org/content/documents/1579SDGs Proposal.pdf) Accessed 7 October 2015

ISSN 2054-4049 doi: 10.1002/geo2.36

United Nations 2014b *System of environmental-economic accounting 2012: central framework* United Nations, New York

United Nations 2015 *Adoption of the Paris Agreement: FCCC/CP/2015/L.9/Rev.1* United Nations, Paris

United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank 2003 *Integrated environmental and economic accounting* (https://unstats.un.org/unsd/envaccounting/seea2003.pdf) Accessed 19 Feburary 2016

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) 2014 *Green growth indicators: a practical approach for Asia and the Pacific* United Nations Economic and Social Commission for Asia and the Pacific, Bangkok

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), Asian Development Bank and United Nations Environment Programme 2012 *Green growth, resources and resilience: environmental sustainability in Asia and the Pacific* United Nations and Asian Development Bank, Bangkok

United Nations Environment Programme (UNEP) 2011 *Towards a green economy: pathways to sustainable development and poverty eradication* United Nations Environment Programme, Nairobi

United Nations Environment Programme (UNEP) 2012a *Indicators: a UNEP green economy briefing paper* United Nations Environment Programme, Nairobi

United Nations Environment Programme (UNEP) 2012b *Measuring progress towards a green economy: draft working paper* United Nations Environment Programme, Nairobi

United Nations Environment Programme (UNEP) 2014a *Measuring the environmental goods and services sector: issues and challenges* United Nations Environment Programme, Nairobi

United Nations Environment Programme (UNEP) 2014b *Using indicators for green economy policymaking* United Nations Environment Programme, Nairobi

United Nations Environment Programme (UNEP) 2015 *Building inclusive green economies in Africa: experience and lessons learned 2010–2015* United Nations Environment Programme, Nairobi

United Nations Environment Programme (UNEP) 2016 *The Partnership for Action on Green Economy launched in Brazil* Press release (http://web.unep.org/greeneconomy/news/partnership-action-green-economy-launched-brazil) Accessed 15 December 2016

United Nations Global Compact (UNGC), United Nations Environment Programme, World Resources Institute and Oxfam 2011 *Adapting for a green economy: companies, communities and climate* (http://pdf.wri.org/adapting_for_a_green_economy.pdf) Accessed 10 October 2015

UN University–International Human Dimensions Programme and United Nations Environment Programme (UNEP) 2014 *Inclusive wealth report 2014: measuring progress toward sustainability* Cambridge University Press, Cambridge

US Department of Commerce 2010a *Measuring the green economy* United States Department of Commerce, Washington DC

US Department of Commerce 2010b *Measuring the green economy: appendix 2* United States Department of Commerce, Washington DC

van der Ploeg R and Withagen C 2013 Green growth, green paradox and the global economic crisis *Environmental Innovation and Societal Transitions* 6 116–19

van Thiel S and Leeuw F L 2016 The performance paradox in the public sector *Public Performance & Management Review* 25 267–81

Victor P and Jackson T 2011 Doing the maths on the green economy *Nature* 472 295

Vossenaar R 2013 *The APEC list of environmental goods: an analysis of the outcome & expected impact* International Centre for Trade and Sustainable Development, Geneva

Waage J and **Yap C** eds 2015 *Thinking beyond sectors for sustainable development* Ubiquity Press, London

WAVES Partnership 2012 *Moving beyond GDP: how to factor natural capital into economic decision making* World Bank, Washington DC

WAVES Partnership 2014 *Turkey signs on as supporter of NCA Initiative* (www.wavespartnership.org/en/turkey-signs-supporter-nca-initiative) Accessed 6 March 2017

Weng Q, Xu B, Hu X and Liu H 2013 Use of earth observation data for applications in public health *Geocarto International* 29 33–16–16

Wiedmann T and Barrett J 2010 A review of the ecological footprint indicator – perceptions and methods *Sustainability* 2 1645–93

Woodward D 2013 *Incrementum ad Absurdum: global growth, inequality and poverty eradication in a carbon-constrained world* World Economics Association, Bristol (http://wer.worldeconomicsassociation.org/files/WEA-WER-4-Woodward.pdf) Accessed 27 June 2016

World Bank 2012 *Inclusive green growth* World Bank, New York

World Bank 2013 *Remarkable declines in global poverty, but major challenges remain* Press release (www.worldbank.org/en/news/press-release/2013/04/17/remarkable-declines-in-global-poverty-but-major-challenges-remain) Accessed 7 October 2014

Zysman J, Huberty M, Behrens A, Colijn B, Tol R S, Ferrer J N, Aglietta M and Hourcade J-C 2012 Green growth *Intereconomics* 47 140–64

ISSN 2054-4049 doi: 10.1002/geo2.36