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Publisher: Routledge

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New Political Economy

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/cnpe20>

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Liam Phelan ^a, Ann Henderson-Sellers ^b & Ros Taplin ^c

^a University of Newcastle, GradSchool and Discipline of Geography & Environmental Studies, Callaghan, 2308, Australia

^b Macquarie University, Environment & Geography, North Ryde, NSW, 2109, Australia

^c University of New South Wales, Australian Centre for Sustainable Mining Practices, Kensington, NSW, 2052, Australia

Version of record first published: 18 May 2012.

To cite this article: Liam Phelan, Ann Henderson-Sellers & Ros Taplin (2013): The Political Economy of Addressing the Climate Crisis in the Earth System: Undermining Perverse Resilience, New Political Economy, 18:2, 198-226

To link to this article: <http://dx.doi.org/10.1080/13563467.2012.678820>

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The Political Economy of Addressing the Climate Crisis in the Earth System: Undermining Perverse Resilience

LIAM PHELAN, ANN HENDERSON-SELLERS & ROS TAPLIN

The Earth system is a complex adaptive system, characterised by non-linear change and with significant capacity for surprise. In times of systemic crisis, such as dangerous anthropogenic climate change, perverse resilience (for example the structural power of fossil fuel interests in the global economy) can threaten overall Earth system stability. Critical political economic analysis recognises climate change as a threat with significant political economic characteristics and implications. However, key dimensions of climate change as a globally coherent phenomenon, including the important implications of Earth system dynamism and non-linear change, can remain unrecognised, mischaracterised or underestimated. In contrast, resilience approaches describe social-ecological systems but neglect the significance of norms and power relations in human societies. This article builds theory by linking key concepts – hegemony and resilience – from neo-Gramscian political economic analysis and resilience approaches to social-ecological systems. Our objective is to generate a new conceptual framework to improve understanding of the role of politics in social-ecological systems. We use climate change and its mitigation to demonstrate the new framework's potential.

Keywords: neo-Gramscian political economy, hegemony, resilience, social-ecological systems, complex adaptive systems, climate change

The sustainability paradox: familiar stability depends on radical change

This article is a first order attempt to link the complex adaptive systems and political economy theory areas in the context of climate change. Coupling

Liam Phelan, University of Newcastle, GradSchool and Discipline of Geography & Environmental Studies, Callaghan, 2308 Australia. Email: Liam.Phelan@newcastle.edu.au

Ann Henderson-Sellers, Macquarie University, Environment & Geography, North Ryde, NSW 2109 Australia.

Ros Taplin, University of New South Wales, Australian Centre for Sustainable Mining Practices, Kensington, NSW 2052 Australia.

neo-Gramscian international political economy theory (Levy and Newell 2005) with resilience approaches to social-ecological systems (Walker *et al.* 2004: xi) gives new insights into the political dynamism of social-ecological systems in crisis. In doing this we generate a new conceptual framework with the potential to illuminate effective and just responses to Earth system failure attributable to anthropogenic climate change.

The Earth system can be conceptualized as a social-ecological system, that is, a complex adaptive system comprising human-social and ecological elements (Berkes and Folke 1998: 65). Resilience approaches to social-ecological systems focus on maintaining system function and stability (Walker and Salt 2006). However, in times of systemic crisis, perverse resilience (Gallopin 1997, in Faye *et al.* 1999: 118), that is, resilience specific to one internal element of the overall system that is at odds with the sustainability of the system, can threaten overall system stability. In this article, we conceptualise the Earth system as a social-ecological system, and the global economy as a subsystem nested within it (Phelan *et al.* 2011a).

The global economy functions currently in a way that is inconsistent with the limits of the Earth system and is threatening the familiar (to humans and our civilizations) stable state of the Earth system (Hansen *et al.* 2005; Rockström *et al.* 2009). The Earth system faces multiple crises, such as species diversity loss and the collapse of resource bases and ecosystem services (Millennium Ecosystem Assessment 2005). Anthropogenic climate change (IPCC 2007a) is a key manifestation of the inconsistencies between the global economy and the Earth system, and a focus of this article. Understanding the Earth as a complex adaptive system highlights an Earth system characterised by non-linear change and with capacity for surprise (Schneider 2004; Schellnhuber *et al.* 2006; Hansen 2007; Rahmstorf *et al.* 2007; Lenton *et al.* 2008). The implications of climate change for human societies are profound and highly uncertain (Hansen *et al.* 2005).

The relationship between the Earth system and the global economy as a subsystem gives what we term the sustainability paradox: maintaining the desirable, familiar stability of the Earth system overall requires radical change in the human-social subsystem(s) nested within it. The sustainability paradox (at planetary and other scales) articulates in systems terms the pressing ecological need for radical societal change to ensure ongoing viability of human society's ecological foundations. This articulation is consistent with many earlier calls (Carson 1963; Meadows and Club of Rome 1972; Schneider 1976; Catton Jr 1980; Daly 1982; Meadows *et al.* 2004).

Both climate change and its mitigation are anthropogenic, that is, anchored in human-social system elements of the Earth system. Resilience approaches to social-ecological systems explain well the threat that climate change presents human societies, for example the notion of impacts cascading across domains and scales (Galaz *et al.* 2006). However, the theoretical approach struggles to explain political economic dynamism within human-social systems, or to provide options for mitigation responses that fully reflect political as well as Earth system constraints.

In the remainder of the article we further explore critical political economy, resilience and complex adaptive systems in relation to climate change. Section

two identifies two limitations to resilience approaches as explanatory of conflict in human-dominated social-ecological systems such as the Earth system. In section three, we propose a conceptual linkage between hegemony and resilience to better account for political-economic dynamism in social-ecological systems. Section four discusses the way in which maintaining overall Earth system stability depends on undermining perverse resilience of hegemonic blocs within the Earth system. Section five concludes the article.

Two limitations of resilience approaches to social-ecological systems: uncritical engagement with norms and the bloodless treatment of power

The complexity approach (Bradbury 2006; Waltner-Toews *et al.* 2008) is still in its infancy and 'tends to employ an eclectic collection of theories and methodologies designed to deepen our limited understanding of the properties of complex adaptive systems' (Finnigan 2006). The orientation remains fluid to some extent, and is yet to crystallise into a clearly articulated theory.¹ Complex adaptive systems (CAS) approaches are a subset of systems approaches and have been applied in a range of disciplines (Hartvigsen *et al.* 1998; Milne 1998; Anderson *et al.* 2005). Kay (2008) traces the origins of modern systems thinking to von Bertalanffy's work in evolutionary biology beginning in the 1920s and his general systems theory (Bertalanffy 1968), and notes the spread of systems approaches in fields as diverse as anthropology, physiology, mathematical biology, cybernetics and management sciences. While systems thinking originated in natural systems fields, human and mechanical systems also adopted the approach, which concerns itself with 'connectedness, context, and feedback ... interactions, relationships and patterns ... [u]nderstanding comes from looking at how ... parts operate together rather than from teasing them apart' (Kay 2008: 7). Kay (2008: 8) describes complex systems thinking as the 'grandchild of von Bertalanffy's general systems theory', emerging in the wake of new science of the 1970s including nonequilibrium thermodynamics, complexity approaches and chaos theory.

Social-ecological systems (SEs) are CASs with human-social and ecological elements. CAS approaches as applied to social-ecological systems are still very much in flux and continue to be advanced (Gallopín 2006; Janssen and Ostrom 2006; Walker *et al.* 2006a). CAS approaches as applied to human-social systems and their environments are consistent with a 'humans in the environment' perspective. At the planetary scale, Lovelock's 'Gaia' (1979, 1988, 2006, 2007) conceptualises the Earth system inclusive of humans and our societies. Both Lovelock's 'Gaia' and Crutzen and Stoermer's 'anthropocene' (Crutzen and Stoermer 2000; Crutzen 2002) acknowledge the Earth system as a social-ecological system, that is, a complex adaptive system comprising human-social and ecological elements. Crutzen's and Stoermer's anthropocene emphasises humanity's new-found significance as a driving force of change in the Earth system.

The concept of resilience has evolved, together with vulnerability and adaptive capacity, to provide a substantive foundation for what have come to be termed resilience approaches to social-ecological systems (Holling 1973; Adger 2006; Folke 2006; Gallopín 2006; Smit and Wandel 2006). Resilience approaches may usefully inform effective and equitable societal responses to the sustainability paradox

defined above. However, to do so may require linking resilience approaches with more established theoretical analyses of political dynamism in human-social systems that better account for conflicts arising from incompatible and even irreconcilable human interests and values. Here we explore two important aspects of resilience approaches to social-ecological systems that underscore the theoretical limitations of the approach as currently applied: (1) an uncritical and non-transparent engagement with norms and values; and (2) a negligent or bloodless treatment of power in human-social systems. In short, resilience approaches to social-ecological systems struggle to respond with normative precision to questions of what (if any) systemic change might be desirable, for whom, and why, and how such change might be achieved. Related questions have recently attracted limited attention (Leach 2008; Ráez-Luna 2008; Leach *et al.* 2010). More broadly, the need for critical approaches to ecology is a central concern in the political ecology arena (Greenberg and Park 1994; Robbins 2004).

Perverse resilience: acknowledging norms and values

Uncritical and non-transparent engagement with norms and values is problematic for theoretical analyses of humans and our societies. David Hume (Hume 2006 [1739]) argued in 1739 that drawing prescriptive conclusions from descriptive premises is a *non sequitur*: an ‘ought’ does not follow from an ‘is’. With reference to climate change, neither the premise that warming of the climate system is ‘unequivocal’ (IPCC 2007b: 5), nor that ‘[m]ost of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations’ (IPCC 2007: 10) automatically lead to the conclusion that we *ought* to mitigate and adapt to climate change.

Climate change mitigation and adaptation are both choices, as are the forms each may take. There is widespread support in general terms for climate change mitigation and adaptation, as expressed for example in the United Nations Framework Convention on Climate Change (UNFCCC) (United Nations 1992). Virtually all United Nations member states are ratified signatories to the UNFCCC. However, and as we discuss below, support for climate change mitigation, while widespread, is not universal, and, we suggest, will not ever be.² Specific forms of policy responses are also choices. Even where there is agreement on mitigation’s desirability, proposals for achieving that objective may be inconsistent and even contradictory. Multiple policy approaches to mitigation and adaptation have been proposed and are being pursued in international, national and sub-national contexts.

Many working with resilience approaches to social-ecological systems have focussed on applying evolving resilience understanding towards more effective Earth system governance (e.g. Gunderson and Holling 2002; Folke 2006). Outcomes include practical examples of effective adaptive management of ecosystems (e.g. Olsson *et al.* 2007), continually evolving analyses of social-ecological systems (e.g. Folke *et al.* 2005; 2007; Young *et al.* 2008) and a growing resilience literature (e.g. Janssen and Ostrom 2006; Walker *et al.* 2006b).

While useful contributions towards better understanding of SESs, such approaches can lack a critical awareness, appearing at times to simply assume resilience is desirable. Similarly to the way the concept of sustainability has become stretched beyond its original meaning to become applied toward a variety of at times contradictory purposes (e.g. the *financial* sustainability of an otherwise ecologically, socially and economically unsustainable resource extraction project), the normative dimensions of resilience are complicated. As Lebel *et al.* (2006) ask: '[t]he resilience of what ... [f]or whom?'

Perverse resilience (Gallopín 1997; in Faye *et al.* 1999: 118) implies a more critical understanding of resilience and refers to resilience within a system that is undesirable to the extent that it is socially unjust, inconsistent with ecosystem health or threatens overall system viability (see for examples of usage Waltner-Toews 2004: 79; School of Environmental Design and Rural Development 2005: 7; Albrecht 2009). An example from Australia, in relation to as yet ineffective national policy and action responses to the threat of anthropogenic climate change, is the continuing perverse resilience of the coal industry in the Hunter Valley region (Evans 2008) and nationally (Hamilton 2001; Pearse 2007, 2009). However, development of the term remains limited and there is ample room for further definitional deliberation; in normative terms, both resilience and perverse resilience remain poorly conceptualised.

Addressing power relations

Resilience approaches to social-ecological systems also provide a bloodless or negligent treatment of power by not addressing power in human societies adequately. By *bloodless* we mean resilience approaches are yet to adequately reflect the reality of political contestation. Groups of humans in political economic systems often have interests and values that are contradictory, even incompatible, and in conflict with maintaining the familiar stability of the Earth system. We argue human society's continuing inability to successfully mitigate climate change reflects this scenario: the climate crisis remains intractable not because of climate system complexity, but because of the phenomenon's political and economic dimensions.

Research into resilience approaches to environmental governance is dominated by regional-scale case studies (e.g. Olsson 2006; Walker and Salt 2006). Walker *et al.* (2006b) cite numerous case studies (for example lakes and wetlands, rangelands, irrigation systems and coral reefs) that have been important to the development and generalisation of the resilience approach. Narratives of success stories involve scenarios in which varied stakeholders concerned about a particular ecological feature or natural resource such as a lake come together and negotiate a sustainable management approach that all can live with (e.g. Olsson *et al.* 2007). However, climate change is a globally coherent phenomenon and a vastly different proposition in some key respects, including spatial and temporal scale, magnitude and severity. All human communities are implicated in various ways and to varying extents with reference to both climate change causation and vulnerability. Effective, equitable and just mitigation requires explicit engagement with power relations internationally and internally to states and societies.

Resilience approaches accommodate the threat climate change presents to human societies as an anthropogenic phenomenon of the Earth system with impacts across system scales and domains. Resilience approaches also accommodate in technical terms the change necessary to ensure an effective response: the message from climate scientists for deep cuts in emissions and the retention of surviving carbon sinks such as forests has come through in relatively accessible language (IPCC 2001, 2007a; Hansen *et al.* 2008; Kerr 2009). However, a grasp of the political challenges of effective and just mitigation remains elusive in resilience terms.

Critical inquiry and the view from political economy

The need to account for norms and power relations in SESs provides an opportunity to call on the critical inquiry tradition. The term *critical* 'is deeply perverse in the plurality of connotations and interpretations (some of them contradictory) it provokes' (Brookfield 2005: 11). We use critical inquiry (or theory) in this article as it is applied to refer to a number of theoretical approaches aimed at 'fundamental political, economic, and cultural transformation of society'.³ In that sense critical theory is distinct from the traditional liberal and conservative thought (Gottlieb 1999: ix). The distinction between traditional social theory and critical theory is

a contrast between a research that seeks merely to understand and a research that challenges... between a research that reads the situation in terms of interaction and community and a research that reads it in terms of conflict and oppression... between a research that accepts the *status quo* and a research that seeks to bring about change. (Crotty 1998: 113)

Thinking critically in this sense is clearly 'an inherently political process' (Brookfield 2005: vii). We draw on the critical inquiry tradition to 'understand not just how the world is but also how it might be changed for the better' (Brookfield 2005: 7), where 'better' is defined as achieving effective and just mitigation of anthropogenic climate change.

Political economy is concerned with 'political economic problems and policy issues', and is interdisciplinary in character because '[r]eal world phenomena do not fit neatly into boxes labelled 'economic', 'social', 'political', or 'cultural'' (Stilwell 2002). Some political economy theorists are recognised as explicitly critical in their approach, including Antonio Gramsci, whose key idea of hegemony we draw on for this article. With regard to anthropogenic climate change, political economy addresses questions of *why* effective mitigation is yet to be achieved (e.g. Paterson 2001), and also suggests limited opportunities and possibilities for achieving the necessary change (Levy and Newell 2002, 2005; Pearse and Stilwell 2008).

In contrast to resilience approaches' focus on the overall state of social-ecological systems, political economy brings focus to disparate interests of actors within the human-social system. Political economy accommodates the notions of interests

(and values) that are in conflict and comparative differences in power relations leading to contested, contingent system stability (Levy and Newell 2002; 2005; Levy and Scully 2007). Newell (2008) for example in discussing the political economy of global environmental governance builds on earlier more general analyses of power and power relations (Cox 1987; Lukes 2005). In short, political economy analysis of environmental issues as addressed in human-social systems (e.g. global environmental governance) focuses squarely on political contestation and dynamism.

Linking political economic analytical insights with complex adaptive systems approaches may sharpen accounts of norms and power in SESs. Political economy is not a replacement for resilience approaches to SESs: political economy is not equipped to describe or analyse with precision SESs in general and climate change as a phenomenon of the Earth system in particular (Phelan *et al.* 2011b).

Coupling complex adaptive systems and political economy

Although not their stated intention, Levy and Newell's (2002, 2005) political economy approach to global environmental governance suggests potential for linking neo-Gramscian⁴ international political economy theory and resilience approaches to SESs. In this section, we review theoretical consistencies and inconsistencies between the two approaches. For this article we have adopted Levy and Newell's (2005) critical neo-Gramscian form of international political economy (IPE) analysis as applied to global environmental governance. We have arrived at this point through investigation of the relationship between insurance systems and the Earth system in the context of climate change (e.g. Phelan *et al.* 2010; Phelan *et al.* 2011b) and with reference to political-economic analyses of the insurance industry and other business sectors in global climate politics (Newell and Paterson 1998; Paterson 1999, 2001, 2005).⁵

Levy and Newell (2005) propose a neo-Gramscian IPE approach to international environmental politics to extend beyond what they describe as overly state-centric international relations (IR) approaches to better account for the important role of non-state actors – specifically business – in environmental politics and governance. In addressing the role of business in environmental politics, Levy and Newell find that, on the one hand, IR approaches are overly state-centric; on the other, management and corporate political strategy approaches are decontextualized from wider relations of power (Levy and Newell 2005: 57). Levy and Newell (2005: 49) present their neo-Gramscian approach as a linking of IR theory at the macro scale and management theory at the micro scale. The neo-Gramscian approach is thus also intended to bridge the two analytical scales.

We propose melding the neo-Gramscian IPE approach with resilience approaches as a further extension again in theoretical analysis of the climate crisis in the Earth system. We mesh Levy and Newell's neo-Gramscian political economy with resilience approaches towards creating an integrated social-ecological system framework (that is, humans in the environment), and with due attention to the role of power and politics in social-ecological systems.⁶

Coupling potential

Both neo-Gramscian IPE approaches to global environmental governance and resilience approaches to social-ecological systems are particularly amenable to further development. On the one hand, Levy and Newell (2005: 53) note ‘the unfinished nature of Gramsci’s notes and the complexity of the theoretical challenge’ and argue the value of Gramsci’s ideas is not in their completeness, but in ‘the inspiration he has given to many contemporary theorists in their treatment of [international political economy] issues’. On the other, evolving resilience approaches (and complex adaptive systems approaches generally) hold great promise and invite continued development.

Both perspectives conceptualise non-equilibrium systems and, in the case of resilience approaches, explicitly and purposively so. Resilience approaches to social-ecological systems by definition are geared towards systems characterised by non-linearity, thresholds, with capacity for surprise, and with the potential for multiple stable states. For its part, Levy and Newell’s (2005) neo-Gramscian approach to environmental governance also focuses on contingent stability in political economic systems. Levy and Newell (2005: 50) argue that hegemony is ‘contingent’, with ‘hegemonic stability . . . rooted in . . . the projection of a particular set of interests as the general interest’.

Resilience approaches to social-ecological systems focus on whole systems’ states and dynamism, cognisant that system state is a function of (1) changes internally to the system and component subsystems, and (2) perturbations from outside the system. Scale is thus an important aspect of system analysis. The term *panarchy* (Gunderson and Holling 2002) describes the relationship between systems at differing scales, with smaller systems ‘nested’ within larger systems, and with systems subject to cross-scale interaction.

In contrast, Gramscian analysis centres on interests and actions of actors relative to each other internally to systems under analysis. Cross-scale interaction is at least conceivable in Gramscian analysis, and is emphasised in Levy and Newell’s (2005) application of the neo-Gramscian approach to global environmental governance. Levy and Newell argue (2005: 53–5) that while Gramsci wrote mostly with reference to national political economies, there is reference in Gramsci’s notes to larger scales (regional and international), and that Gramsci’s key concept of hegemony is applicable in an international context. Levy and Newell (2005: 55) further argue Gramsci’s value in contemporary understandings of environmental governance lies ‘in the concept of hegemonic formations as complex dynamic systems comprising overlapping and interpenetrating subsystems’. This approach to political economy is evocative of the panarchy concept as applied to social-ecological systems.

The theoretical consistencies between neo-Gramscian approaches to environmental governance and resilience approaches to social-ecological systems suggest at least some potential for connection. However the two approaches are neither wholly synonymous nor wholly compatible and differ in important ways.

Firstly, resilience approaches as applied to ecological and social-ecological systems are grounded in ecological reality, that is, they acknowledge the primacy or ‘non-negotiability’ of ecological elements of social-ecological

systems such as ecological limits (Meadows and Club of Rome 1972; Meadows *et al.* 2004). This is consistent with Dryzek's (1987) concept of ecological rationality, which involves consideration of social choice mechanisms in various social systems in terms of their consistency with long-term ecological sustainability. Political economy, even when focussed on environmental governance, generally treats ecological rationality as contextual to the main game, that is, as a backdrop to political economic contestation. Ecological rationality for political economy is thus important, but not the focus.

Secondly, the origin and development of both theoretical approaches are different enough to suggest at least some inconsistencies are likely. Inconsistencies in turn suggest challenges, but perhaps also the possibility of building a conceptual framework⁷ with greater understanding of politics in human-dominated social-ecological systems.

Resilience and hegemony

The relationship between the concepts of *resilience* and *hegemony* provides a linkage between complex adaptive systems theory and political economy theory. Here we outline the way we link the two.

Walker *et al.* (2004) define resilience as 'the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks'. Loss of resilience implies the system state shifting to either an unstable state or an alternative stable state, both of which are unfamiliar.

Gramsci's hegemony 'rests on coalitions and compromises that provide a measure of political and material accommodation with other groups, and on ideologies that convey a mutuality of interests' (Levy and Newell 2005: 49–50). Hegemony describes the dominant position of an alliance of actors and groupings within a political economic system as the projection of a 'particular set of interests as the general interest' (Levy and Newell 2005: 50).

Gramsci's term for the group of actors in a hegemonic position is an *historical bloc*. An historical bloc 'exercises hegemony through the coercive and bureaucratic authority of the state, dominance in the economic realm, and the consensual legitimacy of civil society' (Levy and Newell 2005: 50). The term refers to both:

the alliances among various social groupings and also to the specific alignment of material, organisational, and discursive formations that stabilise and reproduce relations of power and meaning. These two meanings of 'historical bloc' are closely related, for the ability to mobilise an effective alliance requires not just economic side-payments but also discursive frameworks that actively constitute perceptions of interests. (Levy and Newell 2005: 50)

We extend the given interpretation of hegemony and suggest that, in the anthropocene, an historical bloc may be dominant to the extent that it strongly influences

the political economic system in which it is contained *as well as* the larger social-ecological system of which the political economic system is part.

Our focus is the extent to which anthropogenic climate change is an aspect of hegemonic dominance of the state of the Earth system, undermining the familiar stability of the Earth system, and in turn threatening the resilience of human societies and cultures. Anthropogenic climate change is a feature of the long-standing societal commitment to carbon-based economic growth. Over time, the increasing centrality of fossil fuels to economic expansion, combined with an increasing and ultimately overwhelming commitment to economic growth has also led to what can be termed a fossil fuel historical bloc, comprising fossil fuel corporations and industry representative organisations, governments dependent on economic growth for their societal legitimacy, and others (see Newell and Paterson 1998). In neo-Gramscian terms, the fossil fuel historical bloc is structurally powerful (that is, fossil fuels are of central importance to continued economic growth) and resistant to its position being weakened, for example through an ecologically rational shift to a de-carbonised economy. In systems terms this could be described as perverse resilience: resilience in a subsystem of human-social systems that threatens the familiar Earth system stability on which human society depends.

Levy and Newell's (2005) approach emphasises contingent stability in political economic systems, where current stability in the system benefits the historical bloc in a hegemonic position, to the detriment of others. From the perspective of those excluded from the historical bloc and assuming a counter-hegemonic position, the current stability in the system is oppressive and something to be actively contested. Levy and Newell (2005: 49, 64) note one of the benefits of their theoretical approach is the potential to identify (limited) opportunities available to comparatively poorly resourced actors to achieve political economic change counter to the hegemonic interests of the historical bloc through 'sophisticated analysis and strategy, good timing, and some luck' (64). We suggest extending the analysis from political economic systems to social-ecological systems may also be useful, generating a new, integrated understanding of the relationship between hegemony and Earth system resilience, in support of achieving sustainability.

Attention to the broader social-ecological system beyond the perspective from political economy highlights the ecological implications of hegemonism. There is no guarantee that hegemonic dominance of human-social elements of a social-ecological system is consistent with the ongoing stability of the wider social-ecological system. Indeed, climate change – and other global sustainability crises – suggest the opposite is more typical. This is perhaps unsurprising. Social and environmental injustice originating in imbalances in power frequently go hand-in-hand (Pettit 2004; Hayward 2006; Jones 2008: 47–48). The implications of hegemonism are thus particularly significant when we accept environmental justice is integral to ecological sustainability (Agyeman *et al.* 2002, 2003).

A hegemonic system state in neo-Gramscian terms implies a systemic absence of equity, and therefore a compelling rationale for counter-hegemonic contestation. Including attention to the ecological dimension of social-ecological systems raises questions about the relationship between hegemony and the social-ecological system in which it is founded. We suggest hegemonies that

reproduce values and practices inconsistent with system sustainability can be highly undermining of both the socio-economic resilience of groups outside the historical bloc and of social-ecological system resilience overall (Pettit 2004; Hayward 2006). With reference to climate change, the fossil fuel historical bloc, nourished by ideas such as the primacy of economic growth (see Daly 1982) and the substitutability of natural capital (see Hawken *et al.* 1999), is negatively impacting the familiar stability of the Earth system.

This in turn raises important questions about the impact of increasingly threatened Earth system stability on the contingent hegemonic stability enjoyed by the fossil fuel historical bloc. Increasing the precariousness of overall Earth system resilience is contrary and detrimental to the broader societal interest. As such, over time the historical bloc's discursive efforts aimed at securing broad societal acceptance of its specific interests as the societal interest are also liable to be weakened.

The comparative position of the historical bloc may also be undermined materially through reduced Earth system stability. Climate change implies greater Earth system unpredictability. The potential for hegemony over the state of a social-ecological system may also be more limited than potential for hegemonic dominance in a political economic system. While the notion of the anthropocene points to humans as a dominant driver of change in the Earth system, this is not the same as humans having comprehensive – sophisticated, nuanced, directional – control over the course of global environmental change.

Picturing climate politics in the Earth system

Two figures have been developed that together help to describe a way of linking hegemony and resilience in the context of climate change in the Earth system. For both figures we have drawn on resilience approaches that make use of a metaphorical ball moving around in basins or across other features of a stability landscape (e.g. Scheffer *et al.* 2002: 203–204; Walker *et al.* 2004) to represent the state of a social-ecological system, its resilience and its potential for change. Both hegemony and resilience are highly nuanced concepts, however we set some nuances aside in the following figures so as to give full attention to the conceptual linkage we propose between the two concepts.

Figure 1 shows in abstract and metaphorical form near *current* hegemonic influence on the state of the Earth system. Figure 1 represents primarily two dimensions showing a system state ball (hereafter ball), in cross-section and in close proximity to a climate threshold, to reveal how hegemony in the system drives the ball across a system state surface (hereafter surface).⁸ The companion Figure 2 (depicting three dimensions), also abstract, focuses on hegemony's *historical* influence on the state of a social ecological system. Figure 2 shows historical hegemonic impacts in the form of changes over time in the surface's features, and in turn the effect of changes in the surface's features on the ball's location and potential for movement. The state of the Earth system is indicated by the ball's location on the surface, that is, in the relationship between the ball and the surface. Hegemony therefore influences

FIGURE 1. Political contestation over a social-ecological system state's path: getting inside the ball. The three panels (a, b and c) show (beginning at circa 2012) change over a few years in the state of the Earth system and the role of political contestation over climate change mitigation in system state change. Actors and groupings are represented in relation to political contestation by internal balls inside the system state ball, beginning with a *fossil fuel historical bloc* ball, *counter-hegemonic sustainability forces* ball, and smaller *unaffiliated or disengaged actors and groupings* balls. A climate

threshold in the surface is represented, separating the fringes of two stability domains representing two possible stable Earth system states. Dfs (Domain: familiar; stable) is the Earth system state domain that is familiar (to humans and our civilisations) and stable. Dus (Domain: unfamiliar; stable) is an unfamiliar (to humans and our civilisations) domain, and one that is also stable. An example would be the Earth system with a higher average global mean temperature and an ice-free state.

a Now, circa 2012, fossil fuel hegemony: The fossil fuel historical bloc ball is the largest internal ball, reflecting the fossil fuel historical bloc's dominance of the Earth system state. The fossil fuel historical bloc comprises formal and informal networks of actors and groupings with perceived and actual interests reliant on continued societal need for carbon-dependent economic growth. Example actors and groupings constituting the fossil fuel historical bloc include the oil, coal and energy-intensive sectors, and governments relying on continued carbon-dependent economic growth to maintain their societal legitimacy. The fossil fuel historical bloc ball is shown spinning (direction indicated by the longer arrow) within the system state ball. By virtue of its dominance, the fossil fuel historical bloc ball sets the direction taken by the larger system state ball (from right to left – large open arrow), and drives the system state ball's movement across the system state surface. The counter-hegemonic sustainability forces are represented as the next biggest ball, coalesced around shared perceived and actual interests that are in opposition to continued human-social reliance on carbon-dependent economic growth, that is, in opposition to those interests that draw together the actors and groupings comprising the fossil fuel historical bloc. Counter-hegemonic sustainability forces comprise example actors and groupings such as civil society groups campaigning for emissions reductions and governments of small island states clearly vulnerable to rising sea levels. The counter-hegemonic sustainability forces ball is also spinning (arrow indicates direction), but in a different direction. Counter-hegemonic sustainability forces are attempting (unsuccessfully so far) to drive the system state in a direction other than that of the fossil fuel historical bloc. Unaffiliated or disengaged actors and groupings balls are also visible, spinning (arrows indicate direction) generally in a direction that is consistent with that set by the fossil fuel historical bloc (that is, the *status quo*). Examples of unaffiliated/disengaged actors and groupings are individuals and communities who accept the fossil fuel historical bloc's discursive claim that carbon-dependent economic growth is in the general interest, but are not themselves part of the fossil fuel historical bloc, that is, without a strong vested interest in continued carbon-based economic growth. Unaffiliated or disengaged actors and groupings accept the fossil fuel historical bloc's interests as the broader societal interest, consistent with the fossil fuel historical bloc's hegemonic dominance of the system state. Unaffiliated or disengaged actors and groupings are of little consequence for the path taken by the system state ball.

b Near future, a shift in contingent hegemonic stability: The system state ball has been driven outside of Dfs, up and over the climate threshold and into the alternative stable state Dus. However, one feature of contingent hegemony is continually negotiated alliances between actors and groupings. An actor/grouping no longer perceiving its interests as consistent with those of the fossil fuel historical bloc is shown withdrawing from the fossil fuel historical bloc, leading to a weakening in the fossil fuel historical bloc's hegemonic dominance of the system state, reflected in the reduced size of the fossil fuel historical bloc ball. Another actor/grouping is beginning to perceive its interests as consistent with those of counter-hegemonic sustainability forces. The ball representing this actor/grouping is shown joining with the counter-hegemonic sustainability forces, leading to a strengthening of the counter-hegemonic sustainability forces, reflected in the increased size of the ball representing counter-hegemonic sustainability forces. At this time, the fossil fuel historical bloc remains the dominant influence on the system state and continues to drive the ball's path across the surface (large open arrow). Unaffiliated or disengaged actors and groupings remain of little consequence to the path taken by the ball.

In panel **b** the fossil fuel historical bloc has continued to drive the system state ball from right to left. The ball has been driven outside of Dfs, up and over the climate threshold and into the alternative stable state Dus. In practice, the anthropogenic shift in the Earth system from one stable state to another entails crossing a series of climate thresholds of varying significance. Examples could include globally significant Earth system tipping points such as the loss of the Greenland ice sheet; locking into a single mode of El Niño–Southern Oscillation, and disruption of the Indian summer monsoon and the Atlantic thermohaline circulation (Lenton *et al.* 2008). There are many Earth system thresholds, at multiple scales. System thresholds are not always discernible, sometimes even well after they have been crossed (Keller *et al.* 2008). For clarity of representation in Figure 1 we combine all climate thresholds separating the two stable states into a single threshold. As with panel **a**, unaffiliated/disengaged actors and groupings, which are of little consequence to the path taken by the system state ball, are also shown.

c A little later, turning around the system state: Substantial changes in the comparative position of political economic actors/groupings have occurred modifying the system state ball's path. Counter-hegemonic sustainability forces have been enlarged by additional actors/groupings, such that a new sustainability hegemony has come to dominate the system state. This new *sustainability historical bloc* ball is now the largest, reflecting its newly attained dominance of the system state. The sustainability historical bloc's dominance of the system state is driving the system state ball in a new direction: from left to right, that is, across Dus to cross the climate threshold and returning to Dfs. In practice, a system state's return journey to a previous stability domain may be easy, difficult or impossible. System hysteresis⁹ suggests a return journey from Dus to Dfs may be more difficult (that is, the ball travels a different path across the surface) than the outward journey. With reference to the Earth system and climate change, a return to the familiar stable state of the Earth system after climate change may not be possible within a human-scale timeframe, if ever (Solomon *et al.* 2009). Actors/groupings that once constituted the fossil fuel historical bloc have continued to perceive their interests as inconsistent with those of the previous hegemony and have left the fossil fuel historical bloc. The remaining fossil fuel actors/groupings now comprise a counter-hegemonic force, and their reduced influence on the system state is reflected in the reduced size of the newly-labelled *counter-hegemonic fossil fuel forces* ball. Again, unaffiliated or disengaged actors and groupings are of little consequence to the path taken by the system state ball.

and constrains the ball's location, movement and potential for movement across the surface in two ways.

Figure 1 comprises three panels (**a**, **b** and **c**), which together represent the state of political contestation in the Earth system at a sequence of time points, beginning in the present: at circa 2012. Each panel shows a cross-section of a ball, revealing the way the state of political contestation drives the ball across the surface. Within the ball are smaller balls, each representing political economic actors and/or groupings. Figure 1 highlights the first way the ball may change location across the surface, that is, through being driven across the surface.

Expanding the picture of climate politics in the Earth system

In Figure 2 we employ a three-dimensional view and turn our focus to the system state surface in order to represent the way the fossil fuel historical bloc's hegemony has influenced the evolution of the Earth system until now, and in so doing constrained possible futures for the Earth system. Figure 2 depicts the history of

FIGURE 2. Hegemony and climate disruption in the Earth system: distortions in a dynamic system state surface

Three panels (**a**, **b** and **c**) show the impact of cumulative greenhouse gas emissions over ~ 160 years on the stability and potential for stability of the Earth system, depicted as changes in the features of the surface. The two stability domains: Dfs (Domain: familiar; stable) and Dus (Domain: unfamiliar, stable) from Figure 1 are placed in an infinite surface depicted as flat and designated Duu (Domain: unfamiliar; unstable). A dotted line delineates the thresholds between domains.

a Before anthropogenic climate change (circa 1850): The Earth system state surface with one key feature: the large stability domain Dfs, that is, the Earth system state domain that is familiar (to humans and our civilisations) and stable. The system state ball is deep in the cup. Panel **a** reflects the Earth system state before the onset of anthropogenic climate change, that is, at the onset of the Industrial Revolution.

b Early anthropogenic climate change (circa 1950): The Earth system state at an early stage in climate change, for example shortly after the Second World War. Cumulative greenhouse gas emissions into the Earth system has led to the creation of a large new and alternative stability domain in the surface, to the left of Dfs. We label the new domain Dus: it is an unfamiliar domain, and one that

is also stable. The creation of Dus reflects the anthropogenic increase in atmospheric greenhouse gas concentrations that constitutes climate change in the Earth system. Dus unfamiliarity means it entails considerable uncertainty for humans.

Increased atmospheric greenhouse gas emissions also constrain the potential for the Earth system to remain in its current stable state. This is represented as a Dfs that has decreased in size: it is now narrower and shallower. The shrunken Dfs represents reduced potential for Earth system resilience. A decreasing Dfs leaves the ball closer to the edge of the cup. While the ball remains in Dfs (and therefore the Earth system remains stable), its proximity to the edge of the cup represents reduced system resilience. In comparison to the situation represented in panel **a**, both a smaller change in the features of the surface and a smaller shift in the ball's location would move the ball outside of stability domain Dfs.

c Later anthropogenic climate change (circa 2012): The Earth system in a later stage of climate change, that is, the present day. Atmospheric greenhouse gas concentrations continue to increase, making the Earth system state's familiar stability even more precarious. This is depicted by Dfs continuing to shrink, leading to the ball being in even closer proximity to the edge of the Dfs. Dus has enlarged considerably, to the extent that a potential passage for the ball across a climate threshold from Dfs to Dus is created in the surface. As noted for Figure 1, in practice, the anthropogenically-driven shift in the Earth system from one stable state to another entails crossing a series of thresholds of varying size and significance. For clarity of representation we have collapsed all climate thresholds separating the two stable states into a single threshold.

anthropogenic climate change for roughly the ~160-year period preceding that described in Figure 1. It comprises a sequence of three panels (**a**, **b** and **c**) that in an abstract and metaphorical form show the *historical* influence of the fossil fuel historical bloc's hegemony in the Earth system over time on the state of the Earth system, culminating at circa 2012: **a** pre-anthropogenic climate change (that is, circa 1850); **b** early anthropogenic climate change (that is, circa 1950); and **c** later anthropogenic climate change (that is, circa 2012). Changes are in the first instance attributable to anthropogenic climate change, in turn an outcome of the fossil fuel historical bloc's long-standing hegemonic grip on the Earth system. Figure 2 accompanies the earlier Figure 1 where the emphasis was on the internal workings of the ball. In Figure 2 our emphasis shifts to: (1) the location of the ball on the surface; and (2) changes over time in the surface's features that influence and constrain the ball's location.

Stability domains in the surface, expressed as depressions or 'cups', indicate possible stable states for the system: once the ball is in a cup, and while the cup persists, the ball will tend to stay within that domain. Using a surface is helpful for expressing the potential for complex adaptive systems to have multiple stable states, represented as multiple cups in the surface. Theoretical surfaces are infinite and may have other features also. Sloped and peaked areas of the surface, for example, indicate unstable system states, that is, the ball will not tend to stay within such domains. For clarity in Figure 2, the area of the surface is limited and we refer to and depict only three features. These are the two cups located in a third Earth system stability domain. Of these domains (D), one is familiar (f) while the other two are unfamiliar (u). Both cups are stable (s). We label the whole of the surface other than the two stability domains on which we focus as

Duu: a possible system state domain (that is, location for the ball) that is both unfamiliar and unstable. Dotted lines delineate the threshold between domains. In each panel, the state of the Earth system is represented by the location of the ball on the surface. Change in the system state is represented by the ball rolling across the surface. Potential for change in the system state is represented in part by the surface's features. Across the three panels, change in potential for system state change is reflected in changes in the surface's features.

The evolving relationship between hegemony and the Earth system: combining concepts and figures

The Earth system state may change (that is, the ball moves across the surface) in three ways, with hegemony implicated in two. Firstly, hegemony is implicated as an immediate perturbation that influences the system state, as depicted in Figure 1. Change of this kind in the system state is reflected in the ball being driven in particular directions across the surface. Such movement may or may not be in alignment with the surface's features. That is, while the ball will tend to roll down slopes in the surface, a sufficiently strong perturbation can push the ball uphill, for example up and over a threshold.

Hegemonic influence on the system state comprises material, organisational and discursive elements. These include current continuing and even increasing investment in fossil fuel and energy intensive infrastructure and resultant CO₂e emissions (that is, material elements), contemporary formal and informal networks of actors and groupings with substantial stakes in continued economic reliance on fossil fuels (e.g. see Pearse 2007, 2009) (that is, organisational elements) and a continually reproducing societal commitment to carbon-dependent economic growth, even as the implications of continued emissions are clear (that is, discursive elements). Movement of the ball across the surface in response to more immediate perturbations have been likened to a reflection of changes in system variables (Beisner *et al.* 2003). The Earth system is understood as a social-ecological system, complex and adaptive, and comprising ecological as well as human-social elements. Human influences are not the sole drivers of change in the Earth system, but are significant and the concern of this article.

The second way in which the fossil fuel bloc's historical hegemony is implicated in changes in the state of the Earth system is in accumulated changes in the surface's features. The surface is dynamic. While the creation and shaping of features in the surface is not wholly a result of hegemony in the political economic subsystem, human influences are significant.

Hegemony comprises closely intertwined material, organisational and discursive elements (Levy and Scully 2007). In our example, hegemonic influence reflected in the features of the surface comprises (1) anthropogenic atmospheric CO₂e concentrations accumulated over time through increasing industrialisation since 1850 (material elements), (2) the alliances developed and maintained between particular actors and groupings (for example networks comprising the fossil fuel sector, governments dependent on carbon-dependent economic growth for their continued social legitimacy) that since industrialisation have

ensured the political primacy of carbon-dependent economic growth (organisational elements) and (3) the increasingly intensive and rigid commitment to carbon-dependent economic growth (discursive elements). Changes in the surface's features typically occur gradually. Features in the surface have been likened to reflections of system parameters or drivers (Beisner *et al.* 2003).

Lastly, understood as a complex adaptive system, the Earth system state changes continuously and unpredictably in response to non-anthropogenic endogenous perturbations in the system also, for example volcanic eruptions substantial enough to influence the climate system. Endogenous perturbations are a feature of complex adaptive systems and the ball is therefore never static. Complex adaptive systems' movements to equilibrium points are continuously buffeted off course. Even when the ball is resiliently located in a stability domain (represented by a cup in the surface) and tending towards the local equilibrium point (that is, towards the bottom of the cup), the system will not achieve equilibrium. We note this but do not consider it in this analysis.¹⁰ The Earth system, conceptualised as a complex adaptive system, has always been inherently unpredictable. However, its state has been relatively stable for the course of human history, that is, the ball has remained within the one cup. The focus in this article is the manner in which anthropogenic climate change is moving the state of the Earth system from a state of relative predictability to a state of unpredictability, and the implications of that shift.

In summary, the fossil fuel bloc's hegemonic grip on the state of the Earth system over time (evolution from ~1850 to ~2012 depicted in Figure 2) has created a new, unfamiliar and stable potential state for the Earth system, together with a pathway to that state. Additionally, the effect of the fossil fuel bloc's current hegemony in the Earth system (Figure 1 **a**) is to drive the system state from its current familiar state towards the new and unfamiliar state (Figure 1 **b**).

Justice in the anthropocene: undermining perverse resilience

Earth system stability and political economy challenges

There are important political economic challenges in the anthropocene, where (inherently political) anthropogenic dynamism is a dominant driver of change in the Earth system. Maintaining overall Earth system resilience depends on undermining perverse resilience of hegemonic blocs within the Earth system. The familiar stability of the Earth system as the foundation of human societies is in play. The struggle for sustainability is therefore a high stakes game: life as we've known it is in question.

Firstly, social-ecological systems entail limits to political compromise that are not amenable to accommodation or coercion. Lovelock (2006, 2007) can be interpreted as suggesting that Gaia is forgiving, but does not negotiate. Actors in the social-ecological Earth system have been negotiating responses to climate change and other anthropogenic crises amongst themselves for several decades, for example through UNFCCC processes (United Nations 1992). All the while, Earth system limits remain unmoved (Catton Jr 1980).

Secondly, features of the Earth system are inherently challenging, and particularly so as we shift the Earth system to a comparatively less stable state. Actors' interests, and perceptions of their interests, may change over time, in response to

actual and perceived changes in the social-ecological system. Actors' capacities to define (and even comprehend) their strategic, long-term interests in a comparative sense (that is, in contrast to others' interests), and with the goal of achieving or maintaining a hegemonic political economic position, are highly uncertain and, perhaps ultimately, not feasible with any precision in this context. This is because: (1) the key temporal and spatial scales are extremely challenging; and (2) the Earth system is a complex system characterised by non-linearity with the capacity for surprise (Phelan *et al.* 2011b). As noted earlier, significant Earth system thresholds may not be identifiable, even long after they have been crossed (Keller and McInerney 2008; Keller *et al.* 2008; Lenton 2012). Relationships between the Earth system and the global economy (and other subsystems) are continually evolving, and therefore understanding of them is necessarily incomplete.

Maintaining hegemony in a non-linear Earth system is complicated. Undesirable hegemony of values and practices that undermine the resilience of the Earth system will over time compromise the familiar stability of the Earth system, on which humans and our societies depend. In the absence of ecologically effective mitigation of climate change, the loss of familiar Earth system stability will continue, manifested as a succession of globally significant and smaller changes as thresholds are crossed (Lenton *et al.* 2008). Some changes are effectively permanent in human terms (Solomon *et al.* 2009). Anticipated changes are profound, and thus challenging even for those in the historical bloc and more privileged political economic locations more generally. Such changes will impact human populations unequally but comprehensively. Uncertainty around impacts will increase further still as the state of the Earth system continues to change.

If maintaining a hegemonic grip on the Earth system under such conditions is complicated, undermining perverse resilience of the fossil fuel historical bloc under the same conditions also poses a substantial challenge. Nevertheless, under such conditions, opportunities for undermining the hegemony of the fossil fuel historical bloc may arise. As noted earlier, Levy and Newell (2005: 64) argue a neo-Gramscian approach to global environmental governance suggests (limited) opportunities for challenging hegemony. As noted above, climate change threatens the material basis for the historical bloc's dominance as well as discursive efforts to present its specific interests as the broader societal interest. Climate change therefore threatens the contingent hegemonic stability aligned with the historical bloc's dominant political economic position.

The fossil fuel historical bloc's hegemonic dominance is not total and is contested by counter-hegemonic forces with their own overlapping interests. Counter-hegemonic groupings and actors who support ecologically effective and just mitigation hold varying views of what constitutes: (1) the specifics of a desirable outcome; and (2) an appropriate process towards achieving that outcome. Both the power and normative dimensions of climate change demand achieving collective agreement – and then action – on ecologically effective mitigation: an extraordinary challenge. Such agreement is what elements within the fossil fuel historical bloc have actively sought to undermine to greater and

lesser extents (Jacques *et al.* 2008; Oreskes and Conway 2010; Washington and Cook 2011). This results in a long-standing period during which, while information and analysis about the threat climate change presents is more than sufficient and increasing, climate change remains unmitigated. Climate change is no longer helpfully dealt with *primarily* as a science question (e.g. IPCC 2007a), a technology question or even an economics question (e.g. Stern 2006; Garnaut 2008). Achieving ecologically effective mitigation in the Earth system is a socio-political challenge.

Adopting a climate justice perspective

Given the centrality of environmental justice to sustainability (Agyeman *et al.* 2002, 2003), we suggest achieving climate change mitigation is most usefully framed as a justice issue, one where climate justice (Pettit 2004; Hayward 2006) provides an appropriate societal process and goal. A climate justice perspective recognises climate change is due to globally unequal exploitation of fossil fuels historically and currently, and that responsibility for mitigating climate change should be allocated accordingly (FOE Australia 2006).¹¹

Earlier and continuing social movements that entailed radical change (see Powers *et al.* 1997) provide helpful models and metaphors for achieving the social change necessary for effective, equitable and just climate change mitigation. Anti-slavery, universal suffrage, civil rights, peace, anti-apartheid, independence and indigenous land rights campaigns are all examples of grand justice movements either played out at an international scale or with international ramifications (see Zunes *et al.* 1999). In recent years, the global justice movement (sometimes misnamed the ‘anti-globalisation’ movement) has provided an example of global-scale movement building that accommodates multiple specific interests and perspectives. These include perspectives from both North and South, as well as sectorally varied interests, including environmental rights, labour rights and others (Klein 2002; Solnit 2004).

Adopting a climate justice perspective, climate change is understood as a globally coherent environmental injustice originating in the global economy, a subsystem of the Earth system. ‘De-carbonising the economy’, ‘deep cuts in emissions’ and similarly apparently neutral phrases mean, in complex adaptive systems terms, a fundamental redistribution of power and associated changes to the economy in favour of maintaining the Earth system in its familiar (to humans), stable state. Recalling the sustainability paradox however, seeking and achieving conservation of familiar stability in the Earth system, and therefore the viability of human-social systems internal to the Earth system, depends on radical change in human societies.

Achieving radical change is simultaneously a precondition and an outcome of undermining the perverse resilience of the fossil fuel historical bloc. This is a scenario in which various actors’ actual and perceived interests and values are – and will likely remain – in conflict and irreconcilable. It is a scenario in which change implies substantial societal upheaval consistent with earlier successful movements to undermine hegemony. The fossil fuel historical bloc currently defends its hegemonic position effectively, even viciously, and it

would be prudent to expect that to continue. Mindful of the course of the great justice struggles, we suggest the notion that we might somehow effect climate change mitigation without significant and widespread societal conflict appears fanciful.

Movement building is a key feature of the process of social change in human-social systems (Zunes *et al.* 1999) – and therefore in the Earth system as a social-ecological system. Surmounting the profound political economic challenge that climate change presents, that is, challenging and undermining the fossil fuel historical bloc on the scale necessary for maintaining the familiar stability of the Earth system will surely rely on the success of widespread and sustained movement building for climate justice.

Creating a conceptual framework that links critical political economy with resilience approaches, and then applying that framework to climate change at global scale does three things. Firstly, it recognises the scale of the threat climate change presents human societies. Secondly, it accurately identifies the anthropogenic cause of climate change not simply as excessive atmospheric greenhouse gas concentrations, but as the fossil fuel historical bloc's current and historical hegemonic grip on the state of the Earth system. Finally, it suggests necessary remedial action: undermining the perverse resilience of the fossil fuel historical bloc in order to maintain the familiar stability of the Earth system on which human societies depend. Justice provides an inspirational social change goal, and one with which our conceptual approach shows great affinity.

Conclusion: political change in social-ecological systems

This conceptual framework has been developed in the context of climate change and the Earth system, that is, at the global scale. Of necessity, as a first order attempt linking hegemony and resilience, and in the interests of clarity, the conceptual linkage is made at the expense of nuances in both theory areas. We suggest the conceptual approach may be usefully applied in relation to other social-ecological system challenges, and at varied scales. Climate change is a high profile justice and sustainability challenge, but by no means the only one: Rockström *et al.* (2009) identify eight other interacting, globally significant Earth system thresholds, including biodiversity loss, land use changes, freshwater use and ocean acidification. Profoundly important and connected struggles for environmental justice play out at regional, national and smaller scales too.

Resilience approaches are helpful in making sense of social-ecological systems and are typically directed, if generally uncritically, towards sustainability goals. Linking critical political economy to resilience approaches is useful for better explaining political dynamism in social-ecological systems, why desired and/or agreed sustainability goals are yet to be achieved, and what their achievement might require. This is important with reference to understanding the social and political causes of – and responses to – climate change: both climate change and its mitigation are anthropogenic and therefore grounded in the human-social elements of the Earth system.

The sustainability paradox is that to retain familiar Earth system stability overall depends on radical change in the human-social elements of the social-ecological

Earth system. Effective and just climate change mitigation implies profound societal upheaval: certainly the growth and successes of earlier grand justice movements also entailed substantial societal conflict. The fossil fuel historical bloc sees its core interests as wholly wrapped up in continued societal fossil fuel dependency. On this basis it has mobilised skilfully and until now overwhelmingly to defend its self-defined interests which have been threatened by the movement towards mitigation of anthropogenic climate change. This defensive mobilisation by the fossil fuel historical bloc includes characterising its specific interests as the broader societal interest; this is perhaps unsurprising, but certainly inconsistent with maintenance of the Earth system in its familiar, stable state. Against that backdrop, achieving the necessary and profound change to ensure climate justice without significant and widespread societal conflict is extremely unlikely. Earlier grand justice struggles are still live: slavery remains a blight and the positions of women and men in society remain unequal. Those continuing struggles provide a realistic sense of how difficult achieving climate change mitigation will be. However, those struggles also – importantly – can serve as a source of inspiration to those seeking effective and just mitigation. As Solnit (2004: 1) observes, ‘again and again, far stranger things happen than the end of the world’.

Systemic crises in social-ecological systems are challenges with particular qualities. Climate change in the Earth system is a key example. The phenomenon is mediated by climate science, which is vast, difficult and requires training and committed engagement to grasp. The phenomenon’s temporal and spatial scales are challenging for humans and our societies to engage with. The hegemonic forces arranged against effective and just mitigation responses are the most difficult challenge of all. Resilience approaches explain well the manner in which climate change threatens the viability of human societies dependent on maintaining the familiar stability of the Earth system. Critical political economy appropriately sets out the threat climate change mitigation presents to the fossil fuel historical bloc’s hegemonic grip on human societies. In combination, the two approaches articulate the desirability and need for fundamental change in human societies, as well as the challenge in achieving the ecologically necessary change.

Climate change is a ‘diabolical problem’ (Garnaut 2008: xviii). Mitigating climate change effectively and justly means undermining the current fossil fuel historical bloc. Undesirable hegemony over human-social system elements is consistent with the notion of perverse resilience, which undermines the resilience of the larger social-ecological system, upon which humans and our societies are ultimately dependent. Yet even as resilience may or may not be perverse, perhaps hegemony may or may not be unjust or unsustainable. We propose that hegemony consistent with ecological sustainability values may support the resilience of the larger social-ecological Earth system in which the human-social system is constituted. In place of the fossil fuel historical bloc we imagine a new sustainability hegemony with interests explicitly aligned (and recognised as such) with ecologically effective and just maintenance of familiar Earth system stability. Although the relationship between resilience and hegemony requires further investigation, we suggest that a just sustainability hegemony can support a resilient and stable Earth system.

Notes

Sincere thanks to Olivier Rey-Lescure for invaluable assistance with preparing figures – we went back and forth many times, and the figures are better for it. Thank you also to Bonnie McBain, Supriya Matthew and Martin Rice for engaging with the figures in the course of their evolution. Thank you to David Levy, Michele Betsill, Jeff McGee and Hayley Stevenson for sharing insightful comments on the article overall – the article is much improved as a result. Many thanks to the Graduate School of the Environment, Macquarie University, Sydney, Australia, and to colleagues in the Discipline of Geography and Environmental Studies, University of Newcastle, Newcastle, Australia, and the Australian Research Council (ARC) for research support.

1. CAS researchers continue to be more comfortable referring to CASs and CAS *approaches* rather than CAS *theory*. See for example (Levin 1998). Similarly, resilience researchers continue to refer to *resilience thinking* (Walker and Salt 2006) or in other somewhat tentative manners (Walker *et al.* 2006a; Walker *et al.* 2006b) rather than to a *theory* of resilience.
2. Since the 1970s neoliberal ideology has come to dominate public policy spheres in national and international contexts (Harvey 2005; Newell and Paterson 2010). Aly (2010, pp. 84–93) argues that neoliberal climate change denialism is vitriolic in part because the demands of effective climate change mitigation show up the limited ecological appropriateness of responses consistent with neoliberalism, that is, market responses. As such the reality of climate change severely challenges the theoretical foundations of neoliberalism.
3. While ‘critical theory’ is often used to refer to the work of the Frankfurt School theorists such as Horkheimer, it also describes variations of Marxism and feminism, approaches drawing of Foucault and others. See (Crotty 1998, pp. 112–59; Gottlieb 1999; Merchant 1999, pp. 1–25; Brookfield 2005, pp. 1–65).
4. Levy and Newell (2005: 65) ‘use the term “neo-Gramscian” in acknowledgement that [the] conceptual framework does not rely on Gramsci’s writing in any doctrinaire sense and that it also owes intellectual debts elsewhere.’
5. It may be that other approaches to politics and power such as realist international relations theory (e.g. Carr 1939; Morgenthau 1948) can be linked to resilience approaches in the way we link the neo-Gramscian approach. This is not explored in this article. We see value in Levy and Newell’s (2005) explicit attempt to move beyond a state-centric analysis and suggest that a more inclusive conception of who the relevant actors in environmental governance is useful for a conceptual approach that aims to address power in broader social-ecological systems. With reference to climate change at global scale for example, Newell and Paterson (1998) have demonstrated the global climate regime centres not solely on states, but on relationships between states, capital, energy production, and industrial societal reliance on continued carbon-based economic growth.
6. A sub-literature on governance is growing in the social-ecological systems area (e.g. Young 2005; Galaz *et al.* 2006; Folke *et al.* 2007; Young *et al.* 2008). The governance focus addresses the difficulty of designing human institutions, where *institutions* refers to ‘assemblages of rights, rules, decision-making procedures, and programmatic activities that guide or govern human activities’ (Young 2008: 115) with the capacity to deliver effective governance of non-linear social-ecological systems. This is certainly an important challenge. However, conflict grounded in differing interests and values that are contradictory, and even irreconcilable, is not wholly accommodated by better design of social-ecological system management frameworks or governance arrangements. With this in mind, our expectation is that exploring linkages between resilience approaches to social-ecological systems and political economy may also prove useful through explicitly acknowledging and accounting for political conflict and contestation.
7. A conceptual framework is neither a model that describes how things work, nor a theory, which explains phenomena. Rather, a conceptual framework helps to think about phenomena, order material and reveal patterns, which can then lead to models and theories (Rapaport 1985, p. 256; in Berkes and Folke 1998, p. 15).
8. Resilience approaches use the term ‘stability landscape’ (e.g. Walker *et al.* 2004). In the interests of simplicity and clarity, we use ‘system state surface’ to refer to a surface of infinite area that is wholly flat aside from the features necessary for articulating the resilience-hegemony conceptual link.
9. System hysteresis is an important feature of systems with alternative stable states. When a system state passes a threshold and switches from one stable state to another, a simple restitution of conditions immediately preceding the switch may be insufficient for a return to the previous state. Hysteresis implies that after perturbation, the system returns to its original state via a different path. Conditions from an earlier point may need to be reinstated before the system can switch back to its previous state (Scheffer *et al.* 2001, p. 591). See also Budyko (1969).

10. Nor do we address possible exogenous perturbations, for example asteroid impacts, which lie outside the article's focus on linking resilience and hegemony in the context of climate change.
11. The argument so far perhaps also suggests the possibility that a coalition of actors centred on a program of green growth or resource efficiency (that is, ecological modernisation) could arise and provide a countervailing force to the fossil fuel historical bloc, and one that may succeed in achieving climate change mitigation without a commitment to climate justice. We consider environmental justice integral to ecological sustainability, and strong forms of ecological modernisation may also accommodate commitments to justice (Christoff 1996). However weak forms of ecological modernisation, to which the term green growth commonly refers, do not accommodate commitments to environmental justice. Further, green growth is unlikely to deliver ecological sustainability (Hamilton 2003; Jackson 2009; Kerschner 2010; Latouche 2010), and so we discount it as a viable alternative in this analysis.

Notes on contributors

Liam Phelan is Teaching & Learning Coordinator and Senior Lecturer with GradSchool and Conjoint Lecturer with the Discipline of Geography & Environmental Studies at the University of Newcastle, Australia. Liam's research interests include complexity theory, political economy, climate change, insurance and environmental studies.

Ann Henderson-Sellers is an ISI 'most highly cited' author of over 500 publications on climate and climatic change. She is an Emeritus Professor at Macquarie University, and prior to this, she was Director of the United Nations' World Climate Research Programme and Deputy Vice-Chancellor of RMIT University. A Fellow of Australia's Academy of Technological Sciences and Engineering, Ann received the Centenary Medal of Australia for Service to Australian Society in 2003 and holds two DScs as well as a PhD in climate science.

Roslyn Taplin is Professor and Research Director of the Australian Centre for Sustainable Mining Practices at the University of New South Wales, Sydney. Her current research foci are the implications of mining for sustainable development and climate change mitigation and adaptation policy in Australia and internationally. Her key research interest is in the utilisation of scientific information in environmental policy and management.

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