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Anthropogenic Climate Change is Urban not Modern: Towards an alternate critical urban geography

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Abstract

The idea that anthropological climate change is purely a product of modernity (industrialization) is challenged by the contention that such environmental change is many millennia old and is a consequence of urban demand. This argument combines the urban growth theory of Jane Jacobs with the early anthropogenic climate modelling of William Ruddiman and requires a trans-modern sensibility for handling climate change in both theory and practice. We argue for a critical urban geography approach and offer two initial contributions. First, a new urban geographical narrative is constructed to replace the modern progress myth and its top-down political and technological presumptions. Centred on 8,000 years of urban demand, our alternative narrative highlights everyday consumption activities

as the crucial link in the human-environment planetary relation. Second, this leads to suggestions for new 'bottom-up' research agendas, both historical concerning the crucial under-estimation of urban process, and contemporary relating to: the urban demand mechanism, framing a politics of change through cities, and locating cities in the theory of social reproduction. This is an ongoing rethinking exercise that concludes with an invitation to readers to engage and develop this critical research path.

Keywords

Anthropological climate change; cities; modernity; urban demand

'The fragile ecology of a city and the fragile ecology of the Artic stand or fall together'– from a speech by Jane Jacobs in 1970 (Zipp and Storring, 2016, 203)

Introduction

This paper is a supplementary contribution to the argument initiated by eleven antitheses proposed to aid critical understanding of anthropogenic climate change (Taylor et al 2016). In this previous study the antitheses were set against conventional modern theses to challenge how we think about: (i) cities and states in macro-social change, (ii) the way this translates into constricting chronologies and chorographies, and (iii) its crucial implications for climate change science and policymaking. Timings and spacings within the modern mindset are found to be dysfunctional for tackling anthropogenic climate change; reversal to network development through cities brings urban demand to the fore. It is largely a negative message and in this new text we begin moving towards a more constructive agenda. Where might we go from here in our small corner of critical academia?

As previously discussed (Taylor et al. 2016), developing trans-modern scholarship is fraught with knowledge difficulties. In effect, our take on anthropogenic climate change is a provocation to modernity's innate superiority complex. We are downgrading our modern world from ultimate historical climax to just another historical interlude. This changing macro-positionality means we are basically searching for a sort of 'self-reflexivity' at a societal level when we are not even sure that we can ourselves transcend modern sensibilities. We tackle this, as indicated by our title, by transferring the 'anthropo' in contemporary climate change from industrialization as specifically modern to urbanization as generic focus: modern people are not the only humans to influence planetary climate change. From this position we derive two components that comprise our argument: tentative narrative construction and provisional research agenda making.

At the heart of the modern mindset there is grand narrative combining a progress (development) chronology with a mosaic (states) chorography (Taylor et

al. 2016). This can be challenged in two ways, by eschewing grand narrative as legitimate reasoning or by constructing a contrary narrative. In practical terms we think the former is the risky option for radical social change at the macro-level because it leaves a pedagogic vacuum. Thus we confront the modern narrative with an alternative narrative customized for humans' role in planetary climate change. This combines a generic framing – urban demand – with specifics in a story that importantly includes, but does not extoll, modernity.

The second part is equally contentious. Generating research themes from a geohistorical narrative is fraught with potential theory issues. There is a long tradition of critical urban geography that we do not, at this stage, engage with. The 'alternate' in our title means distinctly different critical research; there is no intention of replacement, we are simply plowing a different furrow. Aspiring to be trans-modern creates research questions that are not generally considered in critical urban geography. Perforce our research agendas have a large historical component. Starting from basics, our concern for anthropogenic climate change leads us to investigation of its origins because determining how it first happened - which we link to urban demand - is crucial to understanding it today. In his work on climate change Moore (2014, 4) contends:

> Conceptualizations of a problem and efforts to resolve that problem are always tightly connected. So too are the ways we think the origins of a problem and how we think through possible solutions.

It is in the spirit of this argument that we suggest an alternate research agenda.

Building a narrative

We use Jane Jacobs' (1969, 1984, 2000) theory of cities as economic development to integrate the urban with the temporality and spatiality of anthropogenic climate change. Jacobs' writings on economics have had a mixed reception in geography (Jonas 1986; Jonas and Ward 2007) but leading economists have been more accepting of her ideas (Nowlan 1997). In fact her ideas have been harnessed in both radical and conservative economic thinking: respectively, Krugman (1995, 5) refers to her as 'something of a patron saint of the new growth theory', while Glaeser (2011, 11) accords 'the wisdom of the great urbanist Jane Jacobs' as a key source of his urban economics. Nevertheless, following Jacobs' (1961) pioneering urban radicalism, we use her urban economics because it is specifically appropriate for our critical ends in three key ways. First, the theory is articulated on inside/outside relations of cities expressed as export and import replacement modes of economic growth. This process of cities as the engine of economic development incorporates outside spaces into a single process of change that directly informs scalar inter-relations. The dominant import replacement activity in this theory is a continuous generation of homegrown production, a localization creating concentrated, complex city economies within wider urban fabrics. Second, this conception of city process is set in a supply and demand

framework wherein it is the latter that is the root cause of change. This will be shown to be very important for understanding anthropogenic climate change in contrast to policy prescriptions that generally engage with supply, most notably state negotiations over international carbon reduction. Prioritizing cities à la Jacobs switches concern emphatically to demand: rapacious urban demand. Third, and crucially, Jacobs advocates early urban development that approximately coincides with revisions being made to the timing of anthropogenic climate change by William Ruddiman (2010) which we use below and detail later.

Generics: Understanding the material power of cities

Jacobs' (1969, 2000) theory of urban economic development builds upon her classic book on American cities (Jacobs 1961, 442-62) in which she famously concluded that 'organized complexity' was 'the kind of problem a city is'. This promoted bottom up agency over City Hall. There are hints of this idea in some city and climate change writings, for instance, Bulkeley (2013, 11), referring to Foresight (2008), identifies the 'self-organization of independent actors' as 'radical possibilities for living different urban lives in reconfigured urban economies'. What we aim to do in this section is to tie down this thinking specifically to the nature of cities as loci of economic development. The theory in presented in two parts; first, identifying the special nature cities and city life, and second, delineating the mechanisms that result from this specialness.

The communication advantages of cities. Cities emerged at various times and places across the world as special settlements orchestrating local/non-local relations. According to Jacobs (1969, 35):

> […] [I]n modern and historical times, no creative local economy – which is to say, no city economy – seems to have grown in isolation from other cities. A city does not grow by trading only with a rural hinterland. A city seems always to have implied a group of cities, in trade with one another.

Living in a city as part of a network of cities means a whole new world of enhanced communication, in terms of both quantity and quality. For most of its existence, humanity lived in hunter-gatherer bands of about 150 people involving just intra-band communication plus local contact with neighbouring bands. In contrast, the invention of cities and their networks enabled daily contact with far larger numbers of people, both within and between cities. In addition to this quantitative boost, there was a qualitative effect: regular network relations between cities produces contact with a diversity of non-local people, some of whom move to live in new cities, creating the beginnings of urban cosmopolitanism. It has been estimated that in Catalhörük about 7000BC (in Anatolia, one of the earliest known cities) residents had a human communication enhancement greater than pre-urban people by a factor of nearly 2,700, and for Uruk (in Mesopotamia, perhaps the first great city) about 4000 years later the enhancement factor was over 550,000 (for

details on computation, see Taylor 2013, 99). In other words living in cities totally transformed the density and diversity of communications of people providing direct access to so much more information and knowledge than could ever be experienced in previous non-urban worlds of small human bands.

What difference does this make? According to Glaeser (2011, 7) all this additional communication enables city residents to become 'smarter' than their less connected country cousins; not because they are personally more intelligent but because of enhanced opportunities: they have more and diverse people to learn from who are also 'smarter' from being in cities. In particular, he argues that 'cities speed innovation by connecting their smart inhabitants to each other' to become very creative places. This is the reason cities have such a strong historical track record for creative change: 'cities' are literally synonymous with 'civilizations', which are classically defined as societies organized through cities.[1]

But being 'smarter' is not just about economic innovations; living in cities can instigate collective changes in ways of living. For instance, in the twentieth century, environmental concerns for the future focused upon global population growth featuring predictions between 12 and 15 billion people. But Ehrlich's (1971) famous 'population bomb' has somewhat fizzled out with peak population now expected at 9 to 10 billion. This massive reduction of up to a third is largely due to the changed reproductive decisions of women living in cities. As Brand (2010, 55) tells it: 'City dwellers have few children – the billion squatters like everyone else. Thanks to a by-product of urban growth, the core environmentalist panic over population is quietly being undermined'. This example of mass behavioural change – what Pearce (2010, 246) calls 'the feminization of cities' - shows the potential transformative power of cities in our century.

Glaeser (2011) has titled his book *The Triumph of the City* reflecting the oft-quoted fact that urban dwellers are now a majority of the world's population; he asserts that we are now 'an urban species' (p. 1). But passing the 50% threshold is just part of an incessant trend, a global urban change that is expected to result in perhaps three quarters of the world's population being urban around mid-century. From the perspective of the communication argument this change has potentially

[1] Pye (2014, 54) provides an example of working in a monastery as a counter case to the intense connectivity of cities. In early medieval Northumbria some skilled and clever people were creating beautiful manuscripts using their own inventions. The process is described as follows: "These elaborate decorations meant experiments with new techniques and new tools. Eadfrith of Lindisfarne, in the very early eighth century, started to use lead to draw out his designs on the back of the page; then he set the sketches on a frame of transparent horn or glass and put a strong light behind them so he could consult his design as he painted the page itself. He worked alone so his inventions went no further at this time, they were as hidden as he was, but they were remarkable: he made the first lightbox and the first lead pencil." His method were reinvented several centuries later in Europe's late medieval commercial boom where, unlike Eadfrith's invention, it diffused through cities.

immense consequences: the twenty first century's billions of people are singularly special because, as largely urban dwellers, they encompass city potential for changing ways of living at an historically unprecedented rate. But before we explore the real significance of this it is necessary to specify more precisely the actual mechanisms that make cities so potent.

Jacobs' mechanism of development. When translated into urban economics the two sources of communication advantage – dense and diverse links – are treated as externalities. An externality denotes the context within which a firm operates that is not market defined (i.e. it is 'external' to the market). Cities provide two important positive externalities for firms: (i) agglomeration/cluster externalities within cities whereby firms can take advantage of being close to other firms, and (ii) network/connectivity externalities between cities whereby firms can take advantage of connections with other cities. In combination these make cities into rich places of information flows. As knowledge hubs largely based upon face-to-face contacts in a learning milieu, cities are where both intense and cosmopolitan economic environments are to be found.

According to Jacobs (1969), economic development is a special case of economic change. It is generated by two master economic processes, innovation and import replacement, which are both features of city creativity. In this argument innovation is a function of the size and complexity of cities, where urban problems generate new demands that only these creative places can satisfy through new production and consumption. Import replacing derives from the diffusion of innovations through city networks of creative places, where innovations can be improvised for local production and consumption. Both processes generate new work thereby increasing the complexity of a city's division of labour. It is this dynamic outcome that specifically defines economic development. An economy can grow by just increasing what is already being produced – adding more old work to existing old work such as doubling the output of a factory – but this change does not diversify a city's division of labour and hence does not qualify as development. Thus cities are exceptional settlements because of their complex dynamic divisions of labour resulting from their innovations and import replacements: it is these processes, linking concentration and connectivity, that make cities the prime units of economic development.

This theory posits a world divided between two types of settlement with contrasting economies: complex economies of cities mutually linked through networks, and simple economies of small towns, villages, and farms dependent on cities. Jacobs (1984) describes in detail how this division enables cities to project their economic power and mold far-off economic landscapes to their own needs. The crucial point is that this is a demand theory of economic change wherein demands generated in cities transform economic activities and fortunes in both urban and rural realms. Put simply, what we argue is that cities are inherently demanding, and from which anthropogenic climate change is an unintended consequence.

Linking to Ruddiman's early anthropogenic climate change thesis

A key antithesis from our previous study (Taylor et al. 2016) used Ruddiman's (2003; 2010) argument that anthropogenic climate change is much older than modern industrialization, many millennia older. The evidence supporting his thesis has been thoroughly evaluated in Kaplan et al (2010) and Ruddiman (2013). His basic method is to show how the Earth's climate varies over the long term – what he calls "nature in control' – and then to identify change anomalies in the recent past, which he argues can only be explained by human activities. In this section first we present a summary of Ruddiman's thesis, and second we bring cities into the argument.

Ruddiman's time lines for early anthropogenic climate change. The thesis for change from 'nature in control' to 'humans in control' can be set out as follows.

1. Nature in control is described for both high latitude ice ages and tropical monsoons in relation to Earth's orbital changes. These two cases are related to atmospheric concentrations of the two greenhouse gases, carbon dioxide (CO_2) and methane (CH_4) respectively
2. Glacial cycles were superimposed on a longer-term cooling trend about 2.75 million years ago and are determined by changes in the Earth's orbit that affect the amount of solar radiation received. Cycles of 41,000, 22,000 and 100,000 years are identified in a sequence of between 40 and 50 'ice ages'.
3. Alignment of radiation maxima from orbital tilt (41,000 years) and precession (22,000 years) produces radiation peaks approximately every 100,000 years removing ice sheets from the northern hemisphere. The most recent occurred from 16,000 years ago leading to minimum ice cover 6,000 years ago.
4. In terms of CO_2 concentrations in the atmosphere, Ruddiman finds peak values in relation to the 100,000 year cycles: for the three cycles before the most recent, the peaks occur just before the minimum ice cover
5. In the current cycle the natural CO_2 peak is found 11,000 years ago before minimum ice as previously but the subsequent decline of CO_2 does not continue as expected: about 8,000 years ago the CO_2 trend reverses direction showing increasing concentration of CO_2. It is this anomaly that Ruddiman interprets as humans beginning the take control of climate change.
6. The strength of monsoons is driven by changes in solar radiation caused by the 22,000 year orbital cycle producing a wet-dry climatic sequence.

7. A summertime maximum for solar radiation in the northern tropics occurred 11,000 years ago since when radiation levels have declined to a minimum, so that we are half way through a 22,000 year cycle today.
8. In terms of CH_4 concentrations, generally these are at a maximum at the peak of solar radiation – the wet period produces more vegetation – and the CH_4 levels subsequently decline as the solar radiation reduces and a dryer climate prevails.
9. In the current cycle the CH_4 levels do decline from 11,000 years ago but this abruptly stops and reverses 5,000 years ago. From this point the concentration of CH_4 in the atmosphere increases. This second anomaly is interpreted by Ruddiman as a further effect of humans beginning the take control of climate change.

In creating his early anthropogenic argument Ruddiman specifies separate processes to account for the two green house gas anomalies at 8,000 and 5,000 years ago, both consequences of agricultural activities. Increasing CO_2 from about 8,000 years ago results from the transformation of land cover due to large-scale deforestation for farming. Increases CH_4 from about 5,000 years ago results from the development of wetland rice production in tropical Asia through a dryer period that maintained and increased rotting vegetation levels. In both cases he argues that human induced land cover change modified terrestrial ecosystems to such a degree as to change global climate. Thus Ruddiman's (2010, 6) seminal contribution to climate change science is to add an initial slow long rise in greenhouse gases to the conventional identification of rapid rise in green house gases over the last two hundred years. However, evoking the first stages of agricultural development as the human activity generating early terrestrial atmospheric alterations has received particular skepticism within climate science. And this is where Jacobs (1969) re-enters our argument: she links cities to agricultural revolutions in her 'cities first thesis'. And making this link creates a contribution to Ruddiman's defence of his early anthropogenic climate change thesis by providing a much more powerful social mechanism of change.

Bringing cities in. A very obvious response to the early anthropogenic climate change thesis is that there were simply too few people living in these early times to have made such an impact. Ruddiman has countered this criticism in three main ways. First, the time effect: the impact of changing land cover has been compounded over a very long period. Second, the numbers of people involved in the rise of agriculture has been under-estimated – Gignoux et al (2011) show populations growths in double digits across different regions when agriculture appeared. Third, Boserup's (1965) thesis on the relationship between agricultural intensification and population growth is used to indicate that because earliest agriculture had less population pressure it produced initial very high per capita land cover changes (Ruddiman and Ellis 2009; Kaplan et al 2010). These arguments are

brought together in Ruddiman's (2013) state-of-the-art summary of his thesis and we have no disagreement with them. Rather, by bringing in Jacobs' cities first thesis we add a fourth counter to the idea that early peoples could not have affected global climate change. Not only were there more people than generally thought, they were also beginning to be settled in a new geography – cities. But bringing in cities is not just an addition to Ruddiman's thesis; it provides an explanation for why and how agricultural begins, and it produces a common mechanism of social change capable of creating climate change for both of Ruddiman's slow impact era (early urbanization) and rapid impact era (modern urbanization).

The key connection between Jacobs' and Ruddiman's ideas is that for the former agriculture is a very significant import replacement for the earliest cities. Embryonic cities derive from Neolithic trade networks when production (new work) is added to trading camps. With the consequent urban population growth, existing food procurement from hunter-gathering practices is unable to satisfy the increased demand: agriculture is invented to meet the shortfall. This is Jacobs' (1969) 'cities first thesis': cities emerge in the human story before farming. The conventional view of the very first cities appearing in Mesopotamia several millennia after the coming of agriculture is based on a supply theory of urban origins – cities only appear when agriculture has advanced enough to generate food surpluses to support urban life. To counter this traditional view the alternative demand theory simply asks why hunter-gatherers, whom Sahlins (2004) terms the 'first affluent society' with few wants but much leisure, should choose to invent agriculture and the concomitant extra work (Taylor 2012a; 2013 102-13)). Jacobs' answer is that there was no such rustic invention; agriculture is an early expression of the power of cities to mold their environs for their specific needs. Evidence for early cities across the world is briefly reviewed in Taylor (2013, 138-44). From an orthodox archaeological perspective these large settlements in 'wrong places at wrong times' cannot be locales for inventing agriculture because they are not recognized as cities; this issue has recently been debated, see Smith et al (2014) and Taylor (2015). However Jacobs' shift in interpretation of farming origins in no way lessens the importance of agriculture in terms of the changing land cover outcome as argued by Ruddiman, rather it interprets agriculture as an intermediate step in a process that has its origins in urban demand.

The point we are developing here is not just the idea of farming not happening without urban demand, but that it is through understanding the city economic development mechanism that we can know the fundamental social practices behind human-induced climate change, and which will apply to both its slow and rapid phases. Thus are cities the crucibles of world-changing transformation like agriculture, and why modern industrialization is associated with unprecedented levels of urbanization. Drawing on Jacobs' cities first thesis, Soja (2000) identifies three urban revolutions: the first about 8,000 years ago comprising the origins of urbanization represented by Jericho and Catalhörük; the second about 5,000 years ago is the familiar Mesopotamian urban revolution

(traditionally 'the first cities'); and the third is the massive urbanization of the last 200 years associated with industrialization. The exact temporal matching with Ruddiman's thesis is remarkable. This is elaborated as an original geohistorical narrative for understanding anthropogenic climate change and for how we should respond to it policy-wise.

A new story: critical urban geography for anthropogenic climate change

Humans are different from other species in having two means of social reproduction. All species harness the immediate resources of their environment thus creating a local dependence. The local can be a fixed territory or a moving supply area (seasonal path). Uniquely humans also draw on non-local resources, movement of goods to them from afar (Jacobs 1992). This has always been very clear from archaeological studies, where non-local artifacts – stone tools from distant specific geological sources – are present in excavations. Archaeologists call this 'the release from proximity' (Rodseth et al 1991, 240); although Gamble (2007, 211) has noted that material from further than 'daily foraging range' usually constitutes less than 1% of an excavation assemblage, it does represent 'the local rule broken' and that is the key point. It is not the quantity that matters; a qualitative difference in the manner of social reproduction has been broached. However, the problems of developing the necessary trust with strangers to enable routine trading kept the non-local contribution to social reproduction quantitatively unimportant (Curtin 1984; Graeber 2011). Overcoming this problem enabled the rise of cities.

Evidence of the earliest agriculture is about 12,000 years ago but Ruddiman (2010) shows its climatic impact only from 8,000 years ago. This time lag represents a response time of a slow transition, the first stirrings of urbanization, a stuttering into being of city networks with their new demands for food (Soja 2010). These initial networks are relatively fragile; overall growth is slow but by 8,000 years ago there is clear evidence of substantial urban settlements trading through complex divisions of labour as evidenced by Jericho and Catalhörük (Jacobs 1969; Soja 2000, 2010; Taylor 2012a, 2013). This is the breakthrough of the non-local becoming significant in macro social change. It is this development of multiple vibrant city networks whose creation of new landscapes of agriculture instigates the turnabout of CO_2 that Ruddiman (2010) reports.

However, initially, the long-term resilience of early cities was problematic: surrounding agricultural supply becomes more distant as soils are exhausted finally creating empty quarters and lost cities (Pauketat 2004; Taylor 2013). This outcome is overcome 5,000 years ago with the Mesopotamian city network based upon sustainable irrigation agriculture. Ruddiman (2010) emphasizes tropical Asia's rice cultivation at this point, which he links to rapid population growth; here this is interpreted as early Chinese city networks creating large new demands for food. South Asian and Egyptian riverine cities can also be pushed back to 5,000 years ago. Collectively this is the beginning of the era of large cities in large networks of

cities The first city of 40,000 people is identified in 3300BC as Uruk in Mesopotamia; by 2800 the city has a population of 80,000 and with 10 other cities in its network, the urban population of the region is over a quarter of a million (Modelski 2003, 22; Taylor 2013, 114). Beyond mere demographics there were behavioural changes enhancing consumption. Leick (2001, 10) refers to 'the importance of collective feasting, sometimes called "conspicuous commensuality" – a precursor to "conspicuous consumption"'. Overall, this new level of urban demand requires a social reproduction logistics at a whole new scale, not to mention the outputs, both exports and waste (both human and animal). It is the rise of large cities and their consumption and disposal effects that instigates the turnabout of CH_4 that Ruddiman (2010) reports.

Importantly, such new scales of social activity require new means of governance: the world-changing invention of states (Smith 2003; Yoffee 2005), first as city-states and then empire-states incorporating multiple cities (Taylor 2012a, 2013). This new political dimension is vital to understanding the relatively slow rise of large cities before the modern era. What is happening is that in traditional empires the city development process is replaced by plunder and tribute as the main means of wealth accumulation (Taylor 2013). The largest cities are now typically the imperial capitals that become huge urban centres of consumption but otherwise there is a societal constraint on city development as new work: in all tribute empires, large and small, urban population never passed 10% of total population (Taylor 2013). However, both empires and cities continued to grow and therefore overall the trend is a gradual increase in the collective large city population (Taagepera 1978; Chase-Dunn and Manning 2002), which keeps Ruddiman's (2010) greenhouse gas anomalies moving forward.

In this period of world-empires the rise in CO_2 ceases rising about 2,000 years ago which Ruddiman (2010, 87) explains by the Boserup effect: we would describe this as being the result of increased urban demand leading to improved agricultural technology and thus a reduction in per capita land cover needs. Apart from this clear change in trend, there are also what Ruddiman (2010, 119) calls 'CO_2 wiggles', small variations in the overall pattern. He explains these by reference to large-scale disease epidemics and pandemics that, by decreasing the population, lead to less agriculture and therefore cleared land returning to being covered (p. 132-3). However this can be interpreted as a clear case of fluctuations in urban demand: these diseases are disseminated through city networks and their effects multiplied in dense urban populations (similar to diffusions of innovations – see Verbruggen et al (2014, 50-51)).

Traditional world-empires begin to be superseded by the modern world-system in a transition from about 1450 to 1650 (Wallerstein 1976, 2004). A different historical system emerged where the balance between political and economic elites is readjusted in the latter's favour to create a more balanced power relation between cities and states (Taylor 2013). The result is a new release of urban economic development potential. However, at first this effect of the new

social relations is not reflected in global urban demand increasing CO_2 levels. The obvious reason is that the modern world-system was initially not global, being focused largely in Europe and the Americas. But there is an effect by this new historical system on climate change – initially, 1600 to 1800, the CO_2 levels actually fell in one of the larger 'wiggles' (Ruddiman 2010, 87). So where is the reduced urban demand to cause this decline? An explanation can be found in the greatest disease pandemic of all, that which afflicted the Americas after European contact (Ruddiman 2010, 132-133). This decimated indigenous agriculture and the cities consuming the production, both of which have been conventionally under-estimated – Mann (2011) provides an overview of this demographic process; evidence for Amazonia is set out in detail by Clements et al (2015). More generally in European imperialisms, temperate biomass was reduced before the denser tropical biomass leading to later CO_2 and CH_4 rises (Crosby 2004). Thus the great greenhouse increases precipitated by the modern world-system have an important and very clear time lag.

Ruddiman (2010, 171) starts fast anthropogenic climate change conventionally in 1800 and we can link this change symbolically to our argument through the leading cities of the period: in 1800 Beijing, capital of a traditional empire, was still larger than London, but very soon London became the world's largest city through most of the nineteenth century and beyond. In this time China became incorporated into the modern world-system; the latter became fully global by 1900. This is shown in the enormous increase in large city populations indicating a truly qualitative shift to a new world of great cities as recognized at the time (Weber 1899). Thus instead of labeling the social change as simply 'industrial', the cities approach reinforces Brooke's (2014, 480) argument that the key environmental trigger is immensely heightened urban demand becoming worldwide. For instance, the great urban expansion includes explosive city growth in the frontiers settled by English-speaking peoples as described by Belich (2009; Taylor et al 2010).

However, the urban change in the nineteenth century is more than simply demographic. New ways of living are created. In the modern world, industrial cities changed traditional ways of living into modern clock-based disciplined behaviour in places (factories) and flows (railways). And most important for our argument here, in nineteenth century cities in major countries around the world traditional bourgeois thriftiness morphs into consumption-driven behaviour (Laermans 1993; Dauvernge 2008), as a new way of living (symbolised by the invention and diffusion of the departmental store from the mid-nineteenth century). This behaviour has been inherited and exported as continuously expanding global demand (symbolised by the invention and diffusion of the shopping mall from the mid-twentieth century). This fundamental change in bourgeois behaviour was the consequence of transformation of commerce from being just one element of traditional societies to becoming the dominant feature of modernity as capitalism (Wallerstein 2004, 23-41). This social change finally releases unremitting city

economic processes, resulting in spirals of ceaseless capital accumulation requiring ever-expanding consumption as a truly über-demand.

Thus our narrative ends by returning to how it began, the unique human process of social reproduction. It is the ecological implications of über-demanding cities that are toxic. Harnessing non-local sources of reproduction enabled by trading has today culminated in what Jacobs (2000, 119) calls a 'cultural breaching' of the behaviour necessary to ensure ecological sustainability. She argues that reproduction of any species requires 'traits which prevent it from destroying its own habitat'. For instance, many large animal species develop behaviours that check habitat destruction – these occupy time that could otherwise be devoted to material reproduction. Seemingly 'social activities' prevent damage to the environment that would result from continuous grazing by, for instance, elephants, or incessant hunting by, for instance, lions. It is this 'social' behaviour that prevents full-time exploitation of an environment to its destruction and thereby facilitates reproduction of the herd or pride. Of course, humans have highly developed social behaviours that have checked habitat destruction for most of their existence through reproduction as hunter-gatherers, the leisure-rich 'first affluent society' as described by Sahlins (2004). But the danger of enhanced non-local reproduction is a very different matter, and a few millennia of cities and a few centuries of capitalism have finally undermined whatever evolutionary safeguards were in place.

Towards new research agendas

We have re-positioned how we think about the relations between cities and anthropogenic climate change. This opens up myriad avenues of potential new research enquiry. Here we identify five crucial areas of study for developing critical research agendas in urban geography: (i) adding cities to the 'Neolithic package'; (ii) revising historical urban footprints before industrialization; (iii) policy and the cities-as-demand mechanism; (iv) framing a politics of change through cities; and, (v) locating cities in social theory of reproduction. We provide a skeletal outline of agenda building in each research area through focus on the key issues involved.

Before we describe these agendas there is one key point that needs to be made, something that unites all five selected research paths and the myriad of other research that can be derived from our approach. Cities *in* climate change presupposes urban processes: the collective efforts of urban dwellers, navigating myriad opportunities and obstacles, are directly implicated in changing our global habitat. This implies researching local everyday behaviours in conjunction with their global consequences in inter-scale study that is arguably the *raison d'être* of the field of geography. Currently in climate change science and policy it is states that are centre-stage in the human side of the environment/ humanity nexus. But we argue that this role should be allocated to cities on trans-modern grounds: we

should transcend modern nationalizations of social science knowledge and embrace a critical city-centred focus.

Our approach brings the question of urban origins back to the fore. As Angus (2015, np) argues "determining when radical physical changes in the Earth system happened provides a basis for determining which human activities were responsible, and thus what measures humans might take to prevent the change from reaching catastrophic proportions". But historical urban geography research has not been much concerned for this question since Harvey's (1973) discussion of Wheatley (1971), although slightly later Carter (1983) provided a review of on-going debates including Jacobs' (1969) cities first thesis. More broadly and recently, urban researchers have left the matter to archaeologists, specifically meaning endorsement of Childe's (1950) theory of urban revolution wherein the first cities were built in Mesopotamia 5,000 years ago (Le Gates and Stout 2016, 30-38). Superseding this traditional supply theory of urban origins remains controversial (Smith et al 2014; Taylor 2015) and yet is central to our extension of Jacobs' ideas into anthropogenic climate change. A new research agenda arises from the historical demographic researches that Ruddiman's deploys on challenging conventional climate change thinking.

This research agenda is about adding cities to the 'Neolithic package' of agriculture, villages, pottery and other clay/stone objects. As previously mentioned, Ruddiman's early anthropogenic climate change thesis requires a reassessment of Neolithic populations who are clearing land cover through agro-pastoral practices. Lemmen (2009) has used simulation models combining population totals with land cover maps to estimate induced carbon releases that are too small to support the changes in carbon reported by Ruddiman (2003). Ruddiman (2010) has countered this using larger demographic estimates and higher land clearance per capita ratios; in new modeling (Kaplan et al 2010) Ruddiman and Lemmen are reconciled on this. But this should not be the end of the matter. To estimate land cover removal required for population reproduction, Lemmen uses Gregg's (1988) model of a Neolithic village of 30 persons. This means simulations are based upon subsistence farming in a landscape scattered with multiple very small villages. Without an urban dimension, this betrays an extreme poverty of geographical imagination.

Jacobs' (1969) cities first thesis envisages a much more complex landscape of networks of cities requiring 'rural' land clearances for food, fuel, construction and other uses. Adding this urban geography to the simple demographics of existing simulations is a research agenda that both engages with the initial debate over Jacobs' work as well as informing the Ruddiman climate debate. Data is available from earlier simulations, the new research involves adding cities and resulting complex divisions of labour to create new estimates of induced carbon emissions from both clearance and wider uses of fire. In the original simulations there was just $20km^2$ of forest required for every hundred population practicing subsistence agriculture, in an urban landscape with farmers responding to urban demand there is obviously a need for a much larger forest resource and clearance.

By how much? How can you estimate this? What effect does this have on other parts of the simulations? These are the research questions for urban geographers to explore.

Beyond urban origins, there is a general disregarding of pre-industrial urban populations. This is not for want of data: historical demographers provide population estimates for large cities for the last 5,000 years (Chandler 1987; Modelski 2002). But even when these are employed, the poverty of geographical imagination persists. Nelson (2014) provides a regional analysis of world population that includes global urban population estimates mentioning the leading cities for each period he studies. But an emphasis on just the largest cities rather than complete regional networks of cities means vast numbers of urban dwellers are simply missed out. For instance, in our preliminary work we have focused on 300BC, the first period when we have population estimates for more than fifty cities. But these known cities are just the tip of an urban iceberg. Nelson (2014, 36) provides an urban population estimate of two million; filling in the urban networks for lower levels in the six regions with cities in 300BC suggests a figure of 14 million urban dwellers. Such a seven-fold quantitative difference indicates a basic qualitative different in how early societies are imagined. It underlines a need to critically assess the modern mindset when dealing with urban matters outside modernity. A critical urban geography can totally revise urban footprints before industrialization; even millennia ago, concentrations of 14 million people represent a huge urban demand with consequent huge environmental effects.

The first two research agendas are necessary to consolidate evidence for Ruddiman's long, slow anthropologic climate change through urban process and to show how the cities-demand mechanism may have initially operated. Our narrative rests on this mechanism, which itself constitutes a second broader research agenda. It challenges the prime policy emphasis in climate change: national planning for carbon reduction. In UN conferences such as at Paris in December 2015, states negotiate under conditions of severe lobbying by NGOs to produce targets and timetables to cut their carbon contributions to climate change. As argued in our first paper (Taylor et al 2016) this prioritizing of supply over demand has serious dysfunctional implications. It is only partially corrected by UN sponsored local initiatives; it never recognizes cities as innately demanding.

That cities are inherently demanding, meaning they grow and prosper through expanding consumption by urban dwellers, is not a major theme in urban geography. In fact this key Jacobs' insight is largely implicit at best, perhaps because of a tendency to avoid conceptualizing the contemporary urban in basic economic terms. Thus in describing the 'operational landscapes' of 'planetary urbanization' the relationship between the conventionally urban and 'the urban formerly conceptualized as rural' is portrayed in terms of the latter 'supporting' the former; the 'entire planet is being marshalled 'to serve … urban industrial development' (Brenner 2014, 20-21). This tilts research towards supply patterns of infrastructures, etc. and potentially neglects the cities as the demand complement to

all this supplying. To be sure cities have egregious effects worldwide but the whole story begins in the cities; they do not just 'hinge upon and transform operational landscapes' (Urban Theory Lab GSD 2014, 474), they are the process of demand that produces the operational landscapes. And this is the central point of our approach to anthropogenic climate change. It requires extensive construction of urban geographies of growing global demand. Where are the high-consuming middle classes growing and declining across the world? A starting point might be to map rises and declines in key locales such as shopping malls and car showrooms across the world, differentiating between types of commodities and their ecological footprints.

But the key point from our narrative is that modern mass consumption developed in nineteenth century cities as a bottom-up process of acquisitive behaviour; embedded into modern life, to reverse the now über-acquisitiveness will also be a bottom-up process. Since this development was not created by political (i.e. top-down) policymaking, global, national or local, we should not assume it will be 'solved' by the actions of today's politician's (presidents, prime ministers or mayors) or their policymakers whatever their political will. This is not to say that formal policymaking and implementation is irrelevant (e.g. on reducing carbon emissions), but states negotiating in UN conferences over supply issues while the everyday behaviours of billions of people keep the demand ever increasing is simply bizarre. We agree with Pieterse (2008) that city futures depend on 'everyday urbanism', the continual remaking of cities by their residents and workers. Further, and in light of the urgency in climate change policy, our approach goes beyond intensive research to understand contemporary consumptions. In order not to be part of the current inadequate top-down process, critical urban geography researchers need to address their methodologies in both theory and practice. A trans-modern approach points towards specific methodologies such as participatory action research (Askins and Pain 2011) where people are not the subjects of the research but become 'producers of knowledge in the research process' (p. 806).

This brings us to the politics of climate change through cities. The anti-globalization movements interrupting global governance meetings and the global Social Forums initiated at Porto Allegro and their ilk are necessary political challenges to a dysfunctional world (Smith et al 2011) but in our account they are an insufficient, modern reaction. Collective radical pressure culminating in national revolutions (i.e. as political events) have been successful in the modern world but we are concerned with a 'long revolution', a transition beyond modern consumption. This is a trans-modern shift to change the everyday actual behaviours of billions of people, and, just as important, to change the 'development' aspirations of other billions of people to realize such behaviour. This is the challenge of über–consumption and it is essentially an urban problem. But what political urban geography does this imply? Our interpretation of the problem is that the economic process has colonized the social process in modern city living so that

shopping, in its ever-wider range of guises, has become the dominant leisure pursuit. From a trans-modern approach we know that this does not have to be how cities grow: for instance, historically urban guilds were as much social (religion) as economic (trades). But such a 'historical lesson' is not a marker for the future; this is an area of study that requires some utopian thinking. Current research on green/sustainable cities is proximately relevant but again betrays very limited geographical imagination: a world of green cities scattered across the world's urban landscape is no more insightful than a supposed Neolithic scattering of little villages. There can be no meaningful politics of change without a vision of what might be achieved and in this case a planetary urban vision, a future global urban geography, is essential for recovering the social from domination by material consumption.

We are suggesting a critical urban geography research agenda combining one key aspect of Jacobs' city growth mechanism with Harvey's (2012) recent harvesting of Bookchin's (1995) urban utopianism, but in a broader urban landscape that is now global. As we have shown, Jacobs (1969) theory of urban economic development is essentially a process of continuous localization of innovative change (import replacement) but she also makes clear that not all innovation is economic. Cultural, social, and particularly, political innovations abound in cities along with economic innovations; whether formal or informal, ethical or non-ethical, legal or criminal, they all make up the maelstrom that is urbanism. Currently, research agendas on cities' agglomeration and connectivity practices are largely in the disciplinary territory of economics/business studies/economic geography; by emphasizing their broader urban substance we can explore a trans-modern politics that by-passes modern state-scale political parties as instruments of change (only invented two centuries ago) and search out newly invented political mechanisms conjoining the urban everyday with the urban global. This combines the right to make the city with the right to make the world. The planetary urbanization initiative (Brenner 2014) is working towards this end; our approach suggests bringing anthropogenic climate change to the centre-stage of their emerging agenda as a political urban geography, where blue-sky thinking is encouraged in the light of planetary urbanization being 8,000 years old.

The final agenda derives from understanding that our approach implies much more than a historical reframing of urban geography research. Over several decades, urban research agendas in geography have been strongly influenced by David Harvey's original Marxist exegesis wherein city processes have loomed large (Harvey 1973, 1982/1999, 1985). In this work the urban in multifarious ways is consistently treated as an outcome of broader social processes. Allen Scott (2012; Scott and Storper 2015) is also explicit on this: first know your society and then study its cities. These approaches do not mean that cities are not important, for example they have had vital roles in overcoming financial crises, but they are not the crucial mechanism undergirding social reproduction. Our critical approach turns this around: cities are the instigators of macro-social change not just an

outcome. This is the most overt way that a trans-modern approach challenges modern urban scholarship. We are suggesting that the latter, in both its traditional and radical forms, may have been useful to creators of knowledge for modern purposes but that that this is no longer the case for a world facing world-changing anthropogenic climate change.

Nevertheless we are witnessing of a convergence of thinking in this area. First and most crucial, in recent years Harvey (2014) has moved from emphasis on urban as product to urban as process drawing on the analysis of circulation of money, production and commodity in the second volume of Capital. This matches our emphasis on city growth as demanding. Second, for Harvey the radical political agenda must be played out on a global and local basis, in urban locales rather than nation states, with rebel cities generating political innovations (Harvey 2012, 2015). This clearly parallels our thinking. Third, at this juncture of capitalism, there is a need to embrace a myriad of radical groups, including anarchists, rather than a monolithic single national party to provide opposition to capital. Here we see a huge critical urban geography agenda on the myriad of activist groups making and dreaming of how a safe urban world can be produced for everyone worldwide.

Last but not least, our agendas require the long overdue integration of research on 'Global South' cities and 'Global North' cities, which have tended to go their separate ways (Robinson et al 2016). This is a key unintended benefit of bringing anthropogenic climate change to centre stage in urban geography.

Conclusion as invitation

We have bitten off more than we can chew. This paper and its predecessor (Taylor et al 2016) have attempted to open up a large new critical academic space on the most weighty of subjects. We want to stimulate and antagonize in a typically critical manner but most of all we are hoping for constructive engagement, for genuine help with this critical urban geography journey starting with further discussion in the pages of ACME.

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