The City as Nature and the Nature of the City

Beyond Restoration to 21st Century Bio-Cities

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The 21 Century is the urban century with humans the dominant force shaping the planet's future. This paper outlines why the era's pressing imperatives need transformations in our production and habitation systems. These transformations require ecological design and technical and social innovations for adaptation. These adaptations need new visions of the city as nature and redefining the nature of the city. The paper begins by articulating the concept that all modern cities are forming a single global megacity – named Anthropocencia - linked together by gargantuan flows of information, goods and people. This megacity satisfies its rapacious appetites by drawing resources from a vast global hinterland. But the city is also a place of cultural production where the ferment of new ideas engenders the social and technological innovations needed for adapting to changing circumstances. Thousands of climate responsive and biophilic communities are in active exploration, ushering in transformations, utilising multiple strategies for re-naturing the city and its degraded hinterlands. Influential beyond traditional urban boundaries, cities are evolving assemblages of intertwined cultural, material and ecological elements, spawning novel ecosystems in and beyond urban areas. These 'new natures' are human created in at least four ways. Firstly, all conceptualisations of nature are cultural constructs. Secondly, urban natures exist within the constructed, materially and socially complex systems that are inherently politicised environments. Thirdly, new combinations of biotic and non-biotic elements are forming. Finally, with the Anthropocene simplistic definitional boundaries of 'human' or 'natural' are breaking down. This paper argues that new logics based on recognising the novel co-produced nature of ecosystems can be the basis of the new visions of the city as nature that will drive the forward-looking planning objectives that are needed to support transformations. These socialised objectives may be more useful than attempts to derive goals based on idealised past 'natural' states.

Keywords — *ecological design, novel ecosystems, designer ecology, Anthropocenia*

Introduction

During the 21st century transformation in the forms and functions of cities will be required in order to meet the needs of 9 billion people for food, housing, materials and energy without catastrophically breaching critical thresholds referred to as planetary boundaries (Rockström et al 2009; Steffen et al 2007). Awareness of the planetary scale of these challenges is motivating a suite of creative responses but to achieve these at scale, ecological knowledge needs to be applied systemically and comprehensively in modifying the human forces shaping the planet and its life support systems (Rockström et al

2009; Mathew et al 2014; Norman 2018). The transformations of production and habitation systems require more than dealing with technical changes: they requiring new logics, new perspectives and new visions of the city as nature and the fundamentally reimagining and renegotiating the nature of the city and its relationships (Alexandra 2017a). This paper calls for greater application of ecologically informed planning and design in the adoption of scalable solutions.

Reforming relationships to the environment and the planet encounter underpinning conceptual challenges about how planning and conservation goals are set because we are grappling with the social construction of goals for the trajectories of novel ecosystems (Alexandra 2017a; Backstrom et al 2018). Novelty is enhanced by global anthropogenic impacts like climate change that are making static conservation paradigms redundant (Alexandra 2012). Furthermore most ecosystems can be defined as anthroscapes or anthromes because "humans have reshaped more than three quarters of the terrestrial biosphere into anthropogenic biomes (anthromes), embedding substantial areas of remnant and recovering novel ecosystems within the agricultural and settled landscapes that sustain human populations" (Ellis 2013). As a result anthropogenic changes making idealised pre-development benchmarks of ecosystems increasingly redundant. Instead, this paper looks to how we can work towards achieving socially defined forward looking objectives for integrating human dominated systems and biodiversity conservation. Ecosystem restoration, as either an explicit or implicit goal, can tend to drive backward looking approaches because by definition 'restore' implies looking to an idealised past state. Thus ecological restoration to an idealised past state is not a useful way of setting objectives. However, is often used as the default in conservation planning. This paper explores alternative approaches that aim to use ecological science to support creative endeavours that can be defined as ecologically informed design – or designer ecology - that by definition requires the adoption of explicit future orientated objectives.

This paper is structures in the following way. Section 2 articulates the nature of the planetary dilemmas, exploring the idea that that world has become a single interconnected global megacity (Beaverstock et al 2000), which I have named Anthropocenia.

The paper draws inspirations from the way cities' relationships to nature are being reconceived. These are sketched out in section 3, because while many claim that the global megacity's incessant metabolism and rapacious extractive appetites are the primary source of environmental degradation, it is also productive in terms of material and cultural transformations.

Evidence of these transformations can be found in the way many communities are actively redirecting their environmentally destructive trajectories. These include those actively redressing biodiversity loss (ICLEI 2017) and those who are participating in a huge global program of experimentation in climate responsiveness (Broto and Bulkeley 2013; Alexandra et al 2017). Drawing inspiration from this emerging eco or bio-cities movement, section 4 focuses on how initiatives like urban forestry, renaturing cities, living infrastructure and urban agriculture are redefining the trajectories and purpose of cities (James et al 2009; Andersson et al 2014; Alexandra et al 2017).

Given there are opportunities for using the ecological sciences to inform ecological re-engineering of the human dominated landscapes of cities and their peri-urban and agricultural regions (Andersson et al 2014; Alexandra et al 2017) section 5 explores the logic of further developing the discipline and practice of designer ecology.

The prospects of applied ecology informing design are explored in section 6.This section outlines how ecology as a science can be more usefully applied to reforming and restructuring human dominated urban and rural systems if it becomes integrated within the disciplines and practices of the planning and design professions. Working within the limits of the planet has resulted in the development of various forms of applied ecological design. These ideas have a long intellectual lineage, with many practical expressions that deserve to be critically assessed (Fergusen and Taylor 2014) in the interests of developing the applied discipline of ecological design (Mathew et al 2014). The paper's conclusion calls for a greater focus on creative, adaptive and disciplined ecologically based design as the basis for developing and testing principles and practices suited to the scale and magnitude of the challenges of the Anthropocence.

The Design Brief For The World Mega City - Anthropocenia - And Its Extractive Metabolism

In this, the urban century a fundamental question facing humanity is how to sustain 7 to 9 billion humans and other species (biodiversity) given that the modern world operates as one vast interconnected system relentlessly exploiting natural resources well beyond the boundaries of any specific city or region, in ways that may be breaching planetary boundaries (Steffen et al 2007; Rockström et al 2009).

To comprehend this interconnected system we can conceive of all cities joining to form a single global megacity – Anthropocenia – linked by gigantic flows of information, goods and people (Beaverstock et al 2000). This giant global city is an unprecedented empire of consumption unparalleled in human history. The megacity appropriates a vast global hinterland for supplies of energy, food, fibre, water and raw materials and the ecosystem services needed for its survival (Ellis 2013). On a daily basis, flotillas of ships, innumerable trains, squadrons of planes and billions of motor vehicles deliver the people and materials needed to sustain the megacity's commerce and its institutions of state. In its ceaseless quest for production armies of machines reshape the earth – building, mining, farming etc – while millions of pumps and cascades of dams remodel the world's rivers, catchments and aquifers. Fleets of trawlers dredge the oceans to supply an insatiable desire for seafood. Waste is disposed into coastal and estuarine waters causing eutrophication and into the atmosphere causing climate change.

These pressures will continue with urban areas expected to double in the next 20 years (Norman 2018). Humans have become the world's dominant evolutionary force: technology, consumption patterns and growth in population have delivered unprecedented rates of change to global systems jeopardising the safe operating space for humanity (Steffen et al 2007; Rockström et al 2009). Across and around the megacity a global biodiversity and extinction crisis is unfolding due to the cumulative impacts of the megacities' relentless appetites and its technological prowess in dominating nature on a global scale (Ellis 2013). Climate chaos could accelerate this crisis with intensifying droughts in the mid latitudes and devastating monsoonal floods in the tropics increasing uncertainties, inducing unprecedented pressure for adaptation (IPCC 2012; Alexandra 2012).

The citizens of the Anthropocenia are recognizing that their new challenges and new responsibilities. They are aware that they need to find creative ways of looking after both human needs and their planetary life support systems. They are seeking to learn to "garden" their planet, including by redesigning their urban and agricultural systems based on the emerging discipline of design ecology. A core challenge includes applying 'gardening' methods that align human interest with the goals of sustaining nature.

The design parameters for the desired transformational processes are that the "global city" must continue to function whilst transitioning to a systems that:

- Actively conserves and enhances biodiversity and sustains capacity for critical ecosystem services (Bolund and Hunhammar 1999; M.E. Assessment, 2003);
- Supplies 9 billion people's needs for food, materials and energy resources without breaching planetary boundaries (Rockström et al 2009);
- Rapidly decarbonises by reducing emissions and increasing sequestration (Broto and Bulkeley 2013);
- Has capacity to adapt to chaotic climatic conditions unprecedented since the birth of agriculture (IPCC 2012).

After much democratic debate the citizens of Anthropocenia decide to reformulate their city – the social and physical polis - by committing to the following directions:

1. Reconceiving of their global city as nature including by celebrating and incorporating biodiversity as a priority into the physical, economic and cultural fabric of the polis;

2. Mobilising resources towards biophilic and biodiverse habitation and production systems, working within the city's urban precincts and in its hinterlands;
3. Reforming all supply chains through the certification of fish, forestry and other products (see for example WSA, FSC and IFOAM);
4. Accelerating the disciplines underpinning the design sciences and use of designer ecology to develop and test scalable solutions for use in construction, urban planning, water and energy infrastructure, farming, building and manufacturing and landscape repair (Alexandra et al 2017);
5. Supporting bio-industries like local food production, urban food gardens and peri-urban farming systems that are diverse, draw on permaculture theory and use design based approaches to maximising synergistic benefits;
6. Innovating R&D and innovation systems - unleashing human creativity in all its forms - especially in applied design ecology and sustainability sciences used to reshape the form and functions of the city's eco-material relationships (Alexandra 2017a);
7. Unleashing global programs of land restoration, landscape repair and large scale reafforestation particularly of degraded regions like in Sub-Saharan Africa (see http://blog.worldagroforestry.org/index.php/2016/10/19/what-will-it-take-to-restore-100-million-hectares-of-land-in-africa/)

Reconceiving Cities As Nature And The Nature Of The City

Cities are assemblages of interconnected cultural, material and ecological elements with multiple relationships and networks operating at multiple scales (DeLanda 2006; Grimm et al 2008; Anderson and McFarlane 2011; Dittmer 2014). As coevolving socio-ecological systems (Folke et al 2002; Gual and Norgaard 2010) they have embedded socio-technological regimes and slowly evolving institutionalised logics (Alexandra 2017a; Brodnik et al 2017; Sarewitz 2004; Miller 2001). To cope with the challenges inherent in climate adaptation these need accelerated processes of social learning (Pahl Wostl 2002, 2007&2008 Alexandra 2012 &2017b). Despite constraints of institutional path dependence (Marshall and Alexandra 2016; Alexandra 2017a&b) and the conservative nature of most governance institutions, cities are influential beyond traditional urban boundaries due to their political, cultural and mercantile functions that engender the cultural and institutional capabilities for adapting to changing circumstances (DeLanda 2006; Attali 2009).

Cities not only generate social innovations, they also generate novel ecosystems, both in and beyond urban areas, driven by changes in fundamental processes that change nutrient, material, genetics, energy and water flows (Schaefer 2009). These urban and peri-urban natures are co-produced by humans in at least four ways. Firstly, all conceptualisations of nature are cultural constructs (Castree 2014a). Secondly, urban and rural natures exist in the materially and socially complex systems that are inherently socialised and politicized environments (Heynen et al 2006). Thirdly, new biotic and non-biotic combinations are forming as human move species around deliberately or unwittingly or change conditions that result the decline or increase of some species (Low 2002; Ellis 2013). Finally, with the changing climate of the Anthropocene simplistic definitional boundaries of what is human or 'natural' are breaking down (Castree 2014b) because the whole planet is under varying degrees of human influence (Ellis 2013).

This fundamental blurring of stereotypical nature-culture binaries enables powerful new visions of the city as nature to emerge. It allows us to see cities as full of, built in and embedded in regions of nature (Andersson et al 2014; Alexandra et al 2017). Further, this acceptance enhances our capacity to more actively envisage the transformation of cities so they can become biophilic living cities. Actively re-imagining the future and developing transformative approaches requires imaginatively mapping possibilities (Alexandra and Riddington 2006; Castree 2014b) by engaging people in processes that disrupt and challenge fixed conceptualisations of what is desirable, feasible or likely in the future (Vervoort et al 2015).

New visions in themselves are not sufficient. Successful social innovations are typically produced by broad partnerships building constituencies for reform and discourse coalitions that refashion debates to suit specific political ideologies (Hajer 2005). Thus debates about renaturing or reshaping cities' futures are inherently political (Swyngedouw 2011; Fuller 2013; Appaduri 2013) but also inevitably constrained of preconceived ways of thinking (Rickards et al 2014) and embedded normative frames and institutionalised logics (Sarewitz 2004; Miller 2001; Brodnik et al 2017; Alexandra 2017a). Breaking down these constraints may be a necessary precondition to allowing more holistic visions and embodied expressions of new urban natures and human natures to emerge. Id doing we may begin to better understand and empathise with traditional cultures whose landscape relationships are concurrently material and spiritual (Gammage 2012).

Given that we do not know the full range of possibilities for eco-cities, both expert and participatory planning approaches are needed. Importantly these could focus on open ended scenarios and the setting of forward-looking objectives rather than rely on fixed conceptualisations of how cities function or on idealised pre-development benchmarks for conservation because both approaches tend to reinforce traditional binaries, the divisions between culture and nature that limit options for conceptual and practical explorations of different futures.

The Global Biodiverse Cities Movement

Cities are productive places of material and cultural transformations. Many urban communities are actively exploring ways of re-directing their city, reconceiving of their relationships, reconnecting to the biosphere (Andersson et al 2014; Garrand 2017). They are responding to environmental imperatives like climate change in what can be considered a massive global experiment (Broto and Bulkeley 2013) including through major programs of eco-restoration, reafforestation and urban forestry (ICLEI 2016; Alexandra et al 2017). The burgeoning eco-cities movement has expanding programs of urban greening, water sensitive design and living infrastructure demonstrating the potential for transforming the forms and functions of cities (Alexandra 2017a; Alexandra et al 2017). Useful examples include:

1. major urban biodiversity conservation initiatives (Navarro and Pereira 2012; Goddard et al 2010; ICLEI 2017)
2. the redesign of urban water systems to achieve amenity, liveability and climate resilience (Wong 2006; deHaan et al 2014; Ferguson et al 2013)
3. large scale 'urban greening' to achieve living carbon and urban cooling through the integrated use of street trees, urban forests, open spaces, gardens, vertical green walls and planted roofs (Li et al 2005; James et al 2009; Jim & Chen 2009; Alexandra et al 2017).

Cities and their influences are one of the dominant factors influencing the survival of many species (Standish et al 2009; Garrand 2017) with re-wildling strategies aiming to enhance biodiversity at a regional scale (Navarro and Pereira 2012). However, while increasing the size of the formal conservation estate has been a primary focus of national conservation strategies, it is increasingly acknowledged that management is required across all tenures if conservation goals are to be achieved. Furthermore highly modified landscapes, including cities and urban areas, have a range of conversation values, contributing to biodiversity through conserving or restoring habitats (Chapin et al 2009; Standish et al 2011; Garrand 2017) using strategies that can be scaled up from gardens (Gaston et al 2007; Goddard et al 2010). Andersson et al (2014) recommends more focus on urban contributions to meso-scale networks of habitats, reconceiving of connectivity as occurring both in and through urban areas. Greater Melbourne's Yarra River Corridor of contiguous parks from close to the city to the Yarra River's source in the mountains provides a useful example of this kind of greater urban-regional connectivity.

Ecological awareness and the ecological sciences are contributing to designing and redesigning of our cities with urban renaturing (Garrand 2017). Ecological restoration and re-wilding initiatives are giving expression to an emerging global movement (Diemer et al 2003; Jepson 2016). This movement is sometimes referred to as the Biophilic cities movement (Beatley 2011; Ignatieva and Ahrné 2013) or the biodiverse cities movement (ICLEI 2017).

Urban ecologies should not be thought of as only being remnants of former, pre-existing ecosystems that occurred before a city or suburbs engulfed the countryside. Cities are embedded in networks of ecosystem relationship and are

generating novel ecosystems driven by changes in fundamental processes of nutrient, material, genetic energy and water flows (Schaefer 2009) both in urban areas and by the economic drivers of landuse beyond the urban periphery. Cities are nested in a fabric of biodiversity with remnant vegetation including large trees playing important roles as keystone structures in urban landscapes, increasing bird diversity and providing critical habitat such that tree protection policies need to recognize that large trees are keystone structures in the landscape (Stagnoll et al 2012). Recognising the global biodiversity conservation imperative, applied vegetation strategies can enhance urban biodiversity. Standish et al (2013) identify options including:

1. Conserving and restoring habitat at the fringes of cities
2. Restoring remnants within city areas
3. Managing novel ecosystems, including in public and private gardens.

In summary, urban conservation strategies involve restoring and conserving remnant ecosystems and the management of novel ecosystems (Schaefer 2009; Standish et al 2009; Garrand 2017). The latter deserve serious consideration as part of the way biodiversity conservation challenges are met (Lisle 2010; Low 2002; Ellis 2013). However, with any biodiversity conservation initiatives it is important to consider how goals are set and how ecological theory can be applied in program and urban design and in strategies of adaptive management (Garrand 2017).

Restoration Or Design Ecology?

Through agriculture and urbanisations humans have remodelled much of the earth to meet their needs creating vast Anthromes (Ellis 2013) with many negative consequences for other species. Applied ecology has aimed to reduce these impacts, often with only marginal success which Matthew et al (2015) claim are a result of "design failures, not failures in the science" It is also possible that these failures are compounded by a lack of recognition of the dynamic nature of all ecosystems and the use of static conservation paradigms as the foundation for setting goals.

'Design' or designer ecology approaches and contingent planning modalities are needed that accommodate the challenges of the changing climates of the Anthropocene where historic definitional boundaries of what is human and natural breaking down (Castree 2014a). Idealised pre-development for ecosystems are increasingly redundant, requiring a rethinking of how conservation or restoration objectives are established (Dunlop and Brown 2008; Alexandra 2012).

Anthropogenic impacts including climate change compound existing stressors on ecosystems presenting new challenges for integrated assessment, planning, and management by adding uncertainty and complexity (Alexandra 2012). While understanding of minimally disturbed or reference ecosystems is useful, responses to local and global challenges are not well served by the use of objectives derived from historically derived "natural" benchmarks. Although these are often the dominant ways conservation and restoration goals are established. However it is important to recognise that these goals and objectives are always socially constructed (Backstrom 2018). With the scale and magnitude of anthropogenic drivers of change and the inherent complexity and the dynamic nature of the ecosystems static conservation paradigms are increasingly redundant (Alexandra 2012). More flexible and adaptive approaches are called for due to the complex relationships and non-linear feedbacks between social, ecological, and climatic systems. For example, water resources planning and aquatic ecosystem management needs to adjust to the "death of stationarity" which is undermining the foundations of hydrology making past ways of knowing less reliable (and possibly delusionary) guides to the future (Milly et al 2008).

With new climate parameters (macro climates and urban micro climates) new and different species are filling niches and fulfilling key ecological functions in urban and rural systems due to range expansion, and deliberate or accident introductions (Low 2002). These new assemblages of species result in novel ecosystems where 'weeds' can be both symptoms and causes of major changes to agricultural and urban landscape systems.

If we abandon use of historic benchmarks as derived from reference ecosystems as the basis for setting targets for ecological restoration we are required to ask how to set conservation goals. Defining the goal of conservation programs and the goals of sustainable management of natural resources requires a focus on defining objectives (what is to be achieved) and desirable functions rather than attempting to recreate the exact and specific assemblages of species that represented the prior ecosystem. The setting of goals for novel ecosystems requires recognition of the social construction of conservation goals (Backstrom 2018). Abandoning a static view of natural systems allows introduction of climate change driven dynamism to our models of the environment and helps us to accept that ecosystems can radically shift to altered states (Scheffer et al. 2001). Recognition of the dynamic nature of ecosystems and an increased focus on understanding and working with the key drivers of ecosystems are required to move to a non-static paradigm that is capable of handling non-linear changes and multiple transformation processes (Alexandra 2012).

Accepting the new context of the Anthropocene and the need for designer ecology demands that we rethink how conservation goals are set. We need more research on the challenges of governing not only uncertain climatic futures but also post-natural "natural resource management". These arguments can lead us to conclude that both nothing is natural and everything is natural, even though this may seem contradictory.

In summary, given the arguments outlined above, the use of idealised 'pre-development' benchmarks for biodiversity conservation and ecosystem restoration are increasingly problematic and fundamental rethinking of the ways in which ecological objectives are set is needed. By recognising the co-produced nature of ecosystems we can focus on setting forward-looking planning objectives, rather than attempting to derive goals from idealised past 'natural' states. This leads to the need for a greater focus on a designer ecology.

Designer Ecology - Designer Solutions

Developing and implementing integrated solutions requires design. Design or redesign of systems can be seen as an important approach to solving problems that requires reformulating both the nature of problems and the scope of solutions. Putting together multiple complimentary components into systems that work is a generic design challenge that manifests at many scales. Design can be seen as processes and pathways for solving problems. Passive solar architecture is a useful example: the same skills and materials can be used to build an energy efficient, passive solar houses or poorly orientated buildings that are hot in summer and cold in winter requiring additional, energy intensive heating and cooling for the life of the building.

Global cooperation on the design for systematic innovations could accelerate the transformation of human production and habitation systems, decoupling production, energy and resource use and pollution intensity and help to develop integrated global scale solutions. Furthermore because biodiversity conservation, water and land use, energy production, carbon intensity and global food supplies are intimately linked, these 21st Century challenges need to be conceived not as separate issues but as converging. Given this, there are compelling arguments for addressing these matters in innovative and integrated ways – in designed ways. The policies that support innovation and transformations must also be designed. A landmark Dutch R&D program found that not only are major technological and policy innovations required to respond to sustainability imperatives, but that for global scale solutions to be developed and adopted our systems of innovation need to be overhauled (Weaver et al 2000).

Furthermore, developing the theory and practice of ecological design offers strong prospects for systemic innovation. Pioneering work on permaculture provides some useful examples of the theory and practice of how ecological design can contribute to reorientating the future of urban and agricultural systems (Ferguson & Lovell 2014). Permaculture's agro-ecological or poly-cultural systems aim to maximise productivity through enhancing synergises between multiple symbiotic relationships such as the human, structural and biotic elements of urban and farming systems and their wider landscapes. By taking a designed approach they offer useful examples of attempts to apply designer ecology and are

worthy of further critical investigations. According to Mollison (1988) permaculture involves the conscious design and maintenance of productive human occupied ecosystems that mimic the diversity, stability, and resilience of natural systems like forests. Through design permaculture systems aim for the harmonious integration of landscapes, structures and people so that human needs for food, energy, shelter, and other material needs are provided with minimal negative environmental impacts. Ferguson & Lovell (2014) review of permaculture found at its core the concepts that "systematic site design, emphasizing diversity at multiple scales, integrated water management, and access to global germplasm" can increase productivity whilst "retaining their most desirable attributes of sustainability and multifunctionality."

Permaculture theory emphasises the use of diverse species in an effort to maximize productivity, diversity and the functional relationships between multiple components in order to generate synergies or symbiosis. This approach reflects earlier work by Howard Odum on systems ecology. Ferguson & Lovell (2014) found that permaculture's development was influenced by the ecologist Odum who proposed "the design of novel and productive ecosystems in which species are regarded as distinctive but interchangeable system components which should be selected from a global pool … the distinctive inputs and outputs of each species will connect in novel assemblages" (Odum 1971, p. 280).

The central tenant of working with novel ecosystems to meet human needs is relevant to reinventing the nature of cities. With urban farms movements changing cities and their gardens, cities are becoming 'farms' due to the burgeoning interest in and the many benefits of local and diverse food systems (Wakefield et al 2007). Designer ecology can be applied to creating more sustainable food systems whilst also investments in applied R&D bring new food crops and new poly-cultural systems into wide spread use. Improving food systems at the local and global scale remains critical to the wellbeing and security of billion of people and could be achieved with more concerted effort using redesign to improving the productivity of millions of villages and gardens throughout the suburbs of Anthropencia. By adopting this approach the city is not only nature but also a farm and the farm is now also part of the city and of nature.

Conclusions

This paper argues for new visions and logics to underpin the remaking of cities. A central feature of the new logic is seeing the city as nature and reordering ideas about the nature of the city. Given the scale of the transformational challenges, develop capacity for anticipatory governance is needed (Boyd et al 2015). These can help drive the social, technical and scientific capabilities for adaptation. We need to systematically develop integrated systems that focus on energy, agriculture, biodiversity conservation, community development, improved nutrition and local resilience, through functionally orientated novel ecosystems suited to landscape repair in the anthromes, whether in our cities or the bush.

Design ecology has critical roles to play, bringing together the ecological and design disciplines in ways that stimulate the adoption of innovations needed for scalable solutions. Design ecology can be applied in the transformations of urban and rural systems, but not by looking backward to restoration goals but by looking forward, contributing to the ongoing renovation and modernisation of human production and habitation systems. These are needed at all scales from villages through to mega cities in ways that respond to the new responsibilities of the Anthropocene, reconnecting cities to the biosphere.

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