Plus Urbanism: Using Digital Tools to Realise Urban Landscapes that Create More than They Consume

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Abstract: Throughout the history of urbanization, cities have been conceived in opposition to the 'natural' world. They are cast as consumers of natural resources that are provided by the hinterland of 'nature' or 'not-city'. The urgency of climate change compels landscape architects to transform that consumptive model of urbanism. The infinite complexity of the biosphere, however, makes such an endeavor exceedingly challenging. Using a range of simply defined measurable goals for creating landscapes that create more than they consume, the utility of a range of digital tools offers the possibility of a net-positive 'Plus Urbanism'. This paper outlines the theoretical underpinnings, goals, and tools used towards that end using as a primary case study the design for NEOM Future City in Saudi Arabia. It also outlines the challenges and further development of digital landscape architecture required to realize the goal of Plus Urbanism.

Keywords: Plus Urbanism, World of Three Zeros, regenerative landscapes, digital design, data analysis, performative urbanism, cybernetic landscapes.

1 Introduction

1.1 Digital Landscape Architecture and the Challenges of Climate Change

The increasing body of evidence offered by sources such as the Intergovernmental Panel on Climate Change suggests that urbanism is a key element of human-induced climate change. It suggests that the earth is at a tipping point and that without drastic action to limit temperature rise to 2 degrees a rapid series of climate changes will ensue. (IPCC 2018). The Australian Wildfires are the most recent manifestation of the severity of human-induced Climate Change foreshadowed by the IPCC.

Various authors have referred to a world dominated by human influence since at least 1873 (CRUTZEN 2002). These authors contend that we as a species have changed the earth so radically that it justifies being considered as a new Geological Epoch that has variously been called the 'Noospheric', 'Holocene' or 'Anthropocene' epoch. In terms of contemporary landscape architecture, the term has been popularized by authors such as WELLER (2017).

In 2017 Richard Weller, Claire Hoch, and Chieh Huang authored 'The Atlas for the End of the World' which, through a series of essays, digital maps, and data scapes highlighted the dire future facing the planet stemming from humanities hubris and indifference towards the broader biosphere. It highlights both worrying levels of biodiversity loss that have occurred and the clear and present risk that urban development poses to biodiversity.

Under the auspices of the Ian McHarg Center, WELLER et al. (2019) furthered the discourse with 'The 2100 Project: An Atlas for the Green New Deal' which provided an insight into the ways that the USA could accommodate both population growth and biodiversity growth concurrently.

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In a similar vein, Muhammad Younis, the Nobel Peace Prize winner and visionary founder of the financial constructs of Microfinancing and Social Enterprises has highlighted the extreme socio-environmental challenges facing humanity and yet expresses hope for the future that can be reframed to eliminate the inequalities currently challenging our continued existence. In his 2018 book *A World of Three Zeros* he set out a simply defined set of goals that aimed to achieve zero poverty, zero unemployment and zero net carbon emissions (YOUNIS 2018). The simplicity of that idea as a response to the complexity of the challenges facing our biosphere has inspired the design explorations outlined here.

While much has been made of the existential threat posed by the Anthropocene and the consequent effects of climate change, we must reframe the landscape architectural discourse with a positivist approach that embraces the increasing urbanity of the world. Rather than arguing for the abandonment of urbanity and a 'rewilding' of the world the profession will need to focus on how we will continue to reshape a landscape that is now universally 'Anthropocene'.

If humanity as a species is to survive, we will need to be bold enough to geoengineer the earth for the Anthropocene ecosystems and potentially limitless population growth in an interplanetary environment. Rather than being realized through the dominion of the biosphere, this necessitates that we see humanity as a part of the biotic and abiotic web that realistically represents our current world. In doing so we must take responsibility for creating urban environments that move away from 'doing less damage' towards urban environments that are regenerative and create more than they consume in all respects wherever possible.

This paper outlines these challenges and the potential afforded by computational technology to achieve these goals. It focusses on one example of a conceptual framework for thinking about cities through Aecom's work on a Masterplan competition for the design of the 21st Century City of NEOM in Saudi Arabia. The possibility of an ecological urbanism is integrally connected to the digital processes that enabled its creation. Here we report on an incomplete explorative approach to planning new cities with a wide range of Digital Tools not with the intent of offering Plus Urbanism as an empirically proven methodology but rather to indicate the challenges that face the achievement of seemingly simple objectives.

In closing, the paper speculates on the nature of technology and computation that will be required to deliver on the promise of Plus Urbanism effectively. As a consequence, this paper can be characterized as an essay that provides evidence in support of a technologically enabled set of objectives rather than an empirical report of the scientific method.

2 Conceptions of Nature & Its Integration with Technology

2.1 The Cyborg Landscape

> *"Nature and culture are reworked; the one can no longer be the resource for appropriation or incorporation by the other. The relationships for forming wholes from parts, including those of polarity and hierarchical domination, are at issue in the cyborg world. Unlike the hopes of Frankenstein's monster, the cyborg does not expect its father to save it through a restoration of the garden" (Haraway, 2016)*

Nature is an intellectual construct of man that has been formative to the discipline of Landscape Architecture. However, Nature does not need us. It is not sentient and it is not a discernable conscious being. 'Mother Nature' is equally just an intellectual construct that allows us to rationalize processes as the conscious actions of a deity. I would argue that Nature is a continual evolutionary process that has and always will exist irrespective of humanity. While reductive in its logic, one can argue that Nature is the will to exist and be survived through our creations.

If nature can be reduced to the will to exist then it could be argued that the 'natural' course of any being, organism, biotic or abiotic element is simply to modify its environment to optimize its chances of survival. Evolution for the last 14 billion years has been a journey to more productive, conducive and balanced environments of relative equilibrium. To guide our actions as a species we must respect that philosophical imperative.

As Haraway's quote above indicates, it is no longer possible to distinguish between 'Nature' and 'Culture'. Culture & Cities have become an indistinguishable part of Nature in the Anthropocene. Traditionally, however, cities have always been conceived of in terms of their opposition to 'landscape' or 'nature'. This has led to a conception of cities as consumers of the bounty afforded by nature. Indeed, canonical religious texts have highlighted the understanding that nature provides the limitless bounty for people (or cultures and by extension cities) to exploit. However, the challenge of Climate Change compels that *"the city is no longer something we can understand as architecture, as a mass of formed material that we can distinguish from a non-material void which can be characterized as countryside or periphery"* (READ 2007).

Accordingly, to ensure our survival we must ensure the evolution of our entire cyborgian biosphere. This does not necessitate planetary scale geoengineering but rather each instance of urbanism must commit to the idea of restorative urbanism. However, this does not mean we must return the earth to an earlier state. We as a profession must intentionally seek to change the host ecosystems that we are part of. The will to exist is the root that must drive us to adapt planetary habitats to a greater biocapacity and life in all its forms.

In this sense, technology is not simply a tool to be applied in the management of cities but rather is also a fundamental part of Cyborg Landscapes. This idea moves beyond the concept of 'Smart Cities' where technology is applied to an urban environment. The Smart City discourse is symptomatic of a shallow reading and the concept of the landscape as a Cyborg. To respond to the enormity of the climate crisis a higher-order integration of all aspects of technology and culture must be embraced.

3 Landscape Architecture & Urbanism in the Climate Change Era

3.1 The Discourse on Landscape Urbanism

Since at least 2002 the discourse on landscape architecture has been strongly influenced by the idea of landscape urbanism. Driven by the vision of cities as hybrid territories (or cyborgs) the methodologies of landscape urbanism utilized the power of computational design tools to structure the geometries of urban development through manipulation of landscape dynamics. As the landscape is the medium through which all ecological transactions must pass (WELLER 2006) this conjoined landscapes and urbanism in ways that were trans disciplinary.

Over the first decade of the 21st Century, this discourse extended through to the Ecological Urbanism to expand to three ecological registers of environment, social relations and human subjectivity (MOSTAFAVI 2010).

The discourse focussed heavily on the western examples of parks and post-industrial spaces but broadly failed to provide detailed visions of new cities. This could be related to both the relative limitations of tools and software of the time but also would relate to societies insufficient drive to solve the problems in the first instance. However, the discourse did offer a tantalizing vision of the potential of parametric and data-driven design methodologies.

3.2 Digital Tools that Enabled Landscape Urbanism

Data and the means through which it is processed and utilized for the design of landscapes have played a fundamental role in the evolution of the discourse. As computational power increased and tools became increasingly open-sourced and user-generated a series of tools came into common use for practitioners of landscape urbanism. The following table outlines the key categories and tools that drove the development of the discourse.

Table 1: Listing of digital tools that have enabled landscape urbanism approaches

Category	Primary Tools	Function
Parametric Modeling	Rhino/Grasshopper Revit/Dynamo PythonScript Sketchup/Modeleur	Multiple variable modeling and plugins with user-generated content (mainly Rhino/GH)
Agent-Based Modeling and Machine Learning	Processing Wallecei R	Design decisions through independent agent actions or algorithmic actions
GIS	ArcGIS QGIS GrassGIS City Engine	Geospatial information manipulation and parameter-based analysis
Cloud Computing Services	Sefaira Autodesk Green Building Lumion Sidewalk Labs	Wide range of processor-intensive functions like CFD Wind Analysis, Environmental Modelling, Real Time Visualisation and Energy calculations
Big Data and Analytics	Rapid Miner Flocktracker	'Scraping' and analyzing georeferenced user data for real-time analysis of cities
Environment/Sustainability	EnviMet Autodesk Green Building Sefaira Insight Ladybug (Grasshopper) Honeybee (Grasshopper)	Modeling environmental performance parameters such as daylight, energy generation, and use, wind and OTC. Often cloud-based and sometimes User-Generated (Grasshopper scripts).

These tools are only a small selection of the tools available to designers today. This overwhelming amount of choice highlights the challenges facing designers aiming to plan large urban areas.

The three key issues that arise are that no single tool has an all-encompassing set of capabilities. Datasets for large scale sites can become unmanageable and paradoxically most software does not 'talk' to one another. However, tools such as the Data Translators can offer potential solutions and these will be discussed in later stages of this paper.

The range of software essentially dictates disjointed design procedures that usually are limited by poor interoperability.

Near future technologies such as quantum computers offer the promise of massive leaps in complex computing that would greatly accelerate the modeling and analysis of cybernetic landscapes. Because of the quantum computers powers of superposition, they are uniquely well suited to the complexity of ecosystems and biomes. However, the creation of functional personal quantum computers is not likely to occur in the short term and not in the timeframe to provide solutions to the immediate challenges landscape architects face.

4 Developing the Plus Urbanism Approach

4.1 An Approach Inspired by Simply Defined Goals

What we have come to call 'Plus Urbanism' is an idea that has been driven by several simply defined goals. In all cases, the definition of the goals is extremely simple and easily understood however the execution of the goals is extremely complex and interconnected.

In the introduction of this paper, the approaches to urban transformation outlined by YOUNIS (2018) and WELLER (2017 & 2019) suggest a vision of urbanism that is transformative and driven by simply defined goals.

In the case of YOUNIS, his definition of 'a world of three zeros' is based on very simply expressed goals of zero poverty, zero unemployment, and zero net carbon emissions. Despite the simplicity of its expression, the ideas outlined are incredibly complex challenges framed through the lens of economic measures. The simple and unambiguous expression of the goals and the positivist basis of the argument makes the ideas seem deceptively simple and highly attractive.

In the case of WELLER (2017) the polemic and datascapes that frame the argument also suggest optimism that urbanism can be reconciled with biodiversity at a planetary level. This is grounded in simple bold ideas such as the 'world park' visualized as an ecological transect and the idea of cities as ecologies (WELLER 2017). This proposal is furthered in WELLER (2019) where the datascape that maps the USA in 2100 and identifies how 100,000,000 new citizens can be reconciled with urbanity, ecology, and biodiversity. The authors highlight that their 'new green deal' will be *"a chance to go fast, to think big, and to transform the structures that gave us climate change and inequality; and an opportunity to imagine a world in which things are, we promise, better than you think.*" (WELLER et al. 2019).

In both these instances, the authors speak more to strategies and data then they do smaller-scale design approaches and tools. This leaves practitioners with a major question of how to approach such questions in the face of real estate development standards today. In that respect, the approaches of contemporary design practitioners have furthered the discourse with practical realized approaches to design challenges. WoHa, the Singapore based firm, outlined several indices for their urban and architecture projects that tantalize with the potential for defining realizable goals. These include indices that they define as ‘Green Plot Ratio’ (that measures the amount of green space compared to an undeveloped site), Community Plot Ratio (that measures the amount of communal space compared to pre-development conditions), Civic Generosity Index (that indexes the amount of space provided to the general public in the development), Self Sufficiency Index (that measures the self-sufficiency in terms of Energy, Water and Food) and Ecosystem Contribution Index (that indexes the ecological contribution of a project to the surrounding environment) (HALL 2016). In doing so they provide a series of measures that can be ‘parametricised’ in any development project of any scale in scripts that can provide generative capabilities.

Others such as Stefano Boeri have identified similar approaches that outline approaches to realize hybridized ‘forest cities’ (BOERI 2016).

These approaches combined with the methodologies and philosophies of Landscape and Ecological Urbanism resulted in some experiments that led to the development of the Plus Urbanism Approach.

The Bogacay Creek Masterplan in Antalya realized in 2015 by Perkins+Will was one such example. A major regional masterplan that examined the 900 square kilometer watershed of Antalya to prepare an entire Urban Planning Framework for the city that achieves development goals while concurrently addressing protection of potable water supplies, provision of hydroelectric power, flood mitigation, sea level rise adaptation, stimulation of sustainable agriculture, equitable economic development and substantial improvements in the provision of biologically functional public open space. It realized over 6 million square meters of new development and 12 key infrastructure projects that address the key challenges facing this rapidly expanding city. In terms of digital tools, the project utilized a landscape urbanism methodology heavily reliant on Rhinoceros and Grasshopper scripting. While satisfactory in broad terms this project lacked the measurable aspects that would have enabled self-sufficiency or net positive approaches to energy, water, food and biodiversity in favor of a highly resilient approach.

Following the experiments at the Bogacay Creek Masterplan, the approach was extended in the Mount Masterplan in Oman prepared by Perkins+Will in 2017. The project sought to turn a challenging site into a sustainable design opportunity that extended the Landscape Urbanism approaches tested in the Bogacay Creek project. The sites separation from the urban fabric and its rugged terrain of hills and wadis present a sensible opportunity for a net-zero development that employs a new hydroelectric dam and solar energy along with on-site wastewater treatment and on-site food production to achieve very high levels of sustainability while protecting downstream areas from flash floods. Buildings are conceptualized as prefabricated modules that adapt to the hilly conditions while achieving Passivhaus standards of energy efficiency. Designed with a parametrically derived framework that modeled water flow, topography, slope, aspect, and connectivity the project furthered the aim of creating a project that was environmentally positive in that it created new ecologies, improved flash flood resilience, provided self-sufficiency in energy, food and wastewater recycling.

This project achieved in many instances self-sufficiency and ‘net-zero’ outcomes however it did not achieve this in all aspects of the site systems and did not definitively demonstrate with energy models and other analytical proof.

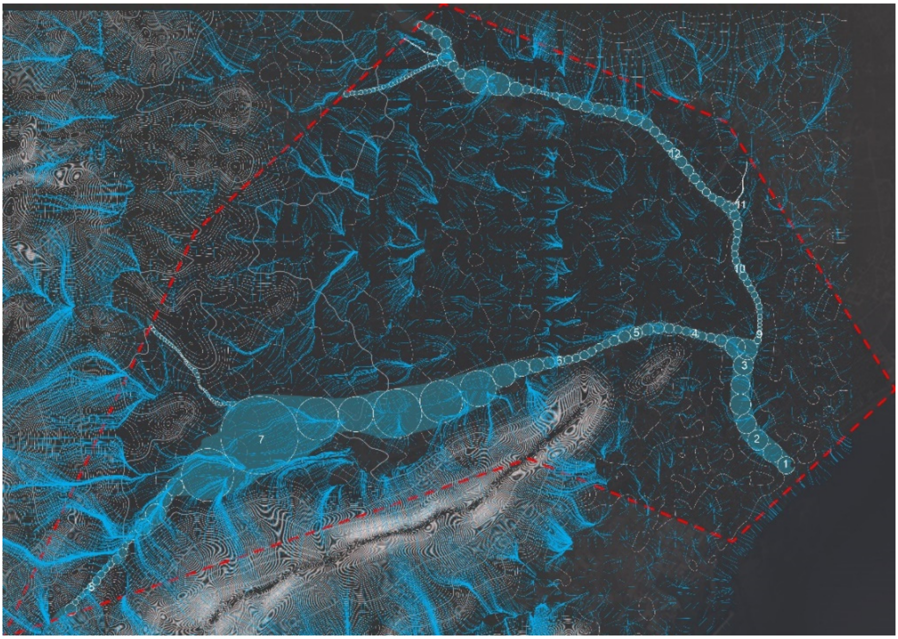

Fig. 1: Watershed Flow Simulation of the Bogacay basin and parametric order of operations diagram

In 2018 we were presented with the opportunity to participate in a Masterplanning Competition for a visionary city on the Kingdom of Saudi Arabia known as NEOM on a 26,000 square kilometer site in the north of the country adjacent to the Jordanian and Egyptian Borders. The mandate for the city was to go beyond anything that had been realized in new cities. That mandate led to an approach that responded to the approaches outlined by YOUNIS and WELLER and extended the methodologies of the Bogacay and Mount Projects.

Also inspired by the examples of WOHA and BOERI the objectives for NEOM were subsequently developed as a beyond-net-zero set of goals. This led to the conception of simply expressed objectives of 'Plus Urbanism'. Plus Urbanism can be defined by the following list of intended outcomes:

- Not just the elimination of poverty – but exporting economic prosperity through social enterprise.
- Not just full employment – but exporting employment and economic catalyzation.
- Not just zero net CO_2 emissions – but negative emissions / atmospheric CO_2 reduction.
- Not just zero habitat loss – but net positive habitat creation.
- Not just zero biodiversity loss – but net positive biodiversity growth.
- Net positive energy production – exporting/storing energy.
- Net positive fresh water production – increasing the supply of freshwater & aquifer recharge.
- Net positive food production – creating more food than the population needs.
- Net positive creation of 'Beauty' – creating landscapes that continually improve on the creation of beauty measured through landscape preference and environmental psychology.

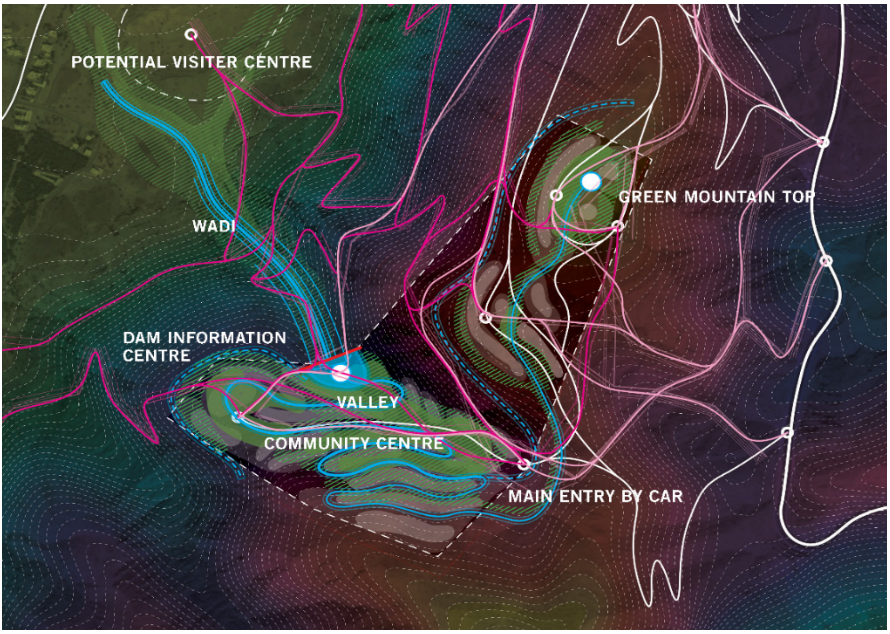

Fig. 2: Illustrative Masterplan and System diagrams for The Mount Masterplan, Oman

Given the intent to develop the framework ideas into an urban planning system to govern the city a multi-tool approach was embarked upon that involved GIS for deep landscape analysis (ArcGIS), BIM for creating one square kilometer design prototypes (Revit/Dynamo), environmental modeling to test performance (Sefaira and Insight), parametric design for both analysis and design of water systems & landscape preference (primarily Rhino/Grasshopper) and data gathering and analysis for Smart Systems (Flocktracker and Rapid Miner). This led to multiple work fronts which are demonstrated in the series of outcomes shown in Figure 3.

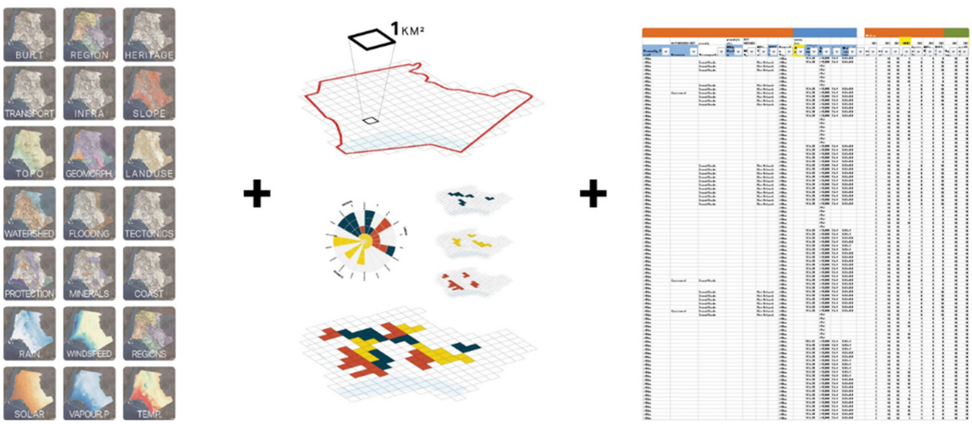

Fig. 3: Multi-Tool Outputs for NEOM Masterplan

The experience of the design team established that the tools available were capable of achieving the stated goals of net-positive outcomes for physical design elements but increasingly the individual outputs were 'fractured' in the sense that the outputs of one software were not transferable to the other. Other objectives such as the economic objectives were difficult to demonstrate as their tangible physical outcomes were not tied to highly specific spatial design solutions but rather to policies and practices. This left the team in the frustrating position of knowing the Plus Urbanism goals set were by and large attainable on an individual basis but were not able to be seen cohesively as an interoperable system.

Ultimately as a limited duration design competition, the project did not allow for the creation of a seamless, parametric dashboard that could allow combinations of design parameters to interact iteratively. This has been the subject of our subsequent research which continues today.

We are currently commencing research that focuses on interoperability that is enabled by data translators such as FME by Safe Software. The FME service translates the output of all spatial design data to common languages, eventually leading to spreadsheet formats that ultimately feed into a dashboard. The dashboard does not only allow the perusal of outputs but also allows the modification of design in reverse by changing values in the dashboard. Our work intends to provide a robust aggregator that can incorporate any tools that develop as well as scripts and plugins as they emerge.

In this way, the use of a multitude of tools is enabled in a manner that is malleable and can respond to tools and hardware as they develop.

Beyond this, it is envisaged that the development of hardware such as quantum computers will provide the ability to simulate the performance of iterative designed systems simultaneously which would highlight develop the system efficacy further. It should also be noted that other parallel initiatives such as the Google Sidewalk Lab may also provide cloud-sourced means to achieve the same ends.

5 Conclusion and Outlook

The pressing need for a response to climate change is clear and unambiguous. Equally the philosophical imperative to see landscapes as dynamic cybernetic systems to respond to the challenges of climate change has been clearly outlined in recent landscape architectural theory.

Considering the urgency of the IPCC's reporting it is clear that all projects at all levels and scales must aim to be at least carbon neutral. As an increasingly urbanized species, we cannot afford the luxury of procrastination.

As outlined in the paper, the technological tools exist that allow us to achieve many of the goals of Plus Urbanism, however, we lack how to do it in an integrated and seamless manner. The NEOM project while incomplete provides an intriguing insight into how the project can provide visionary outcomes with existing tools.

Our future work on the development of the idea focusses on the digital platform that will allow the seamless integration of these elements and even further beyond the ways that quantum computing may add the possibility of complex outcome simulations to the system in the long term.

At all levels, this is a project of immense complexity that will likely require continual development. The need for such development is beyond doubt.

References

BINGHAM-HALL, P. & WOHA ARCHITECTS (2016), Garden City Mega City: Rethinking Cities for the Age of Global Warming. Pesaro Publishing, Balmain Australia.

BOERI, S., MUSANTE, E. G. & MUZZINGRO, A. (2015), A Vertical Forest. Instructions booklet for the prototype of a forest city. Corraini Edizioni, Mantova, Italy.

CRUTZEN, P. J. (2002), Geology of Mankind. Nature, 415 (6867), 23.

DOUGHERTY, W. W. et al. (2009), Climate Change: Impacts, Vulnerabilities and Adaptation: Coastal Zones in the United Arab Emirates: Water Resources in Abu Dhabi: Dryland Ecosystems in Abu Dhabi, Fotos von Xavier Eichaker. Environment Agency, Abu Dhabi. https://www.ead.ae/Documents/RESEARCHERS/Climate%20 change%20impacts%20-%20Eng.pdf.

HARAWAY, D. J. (2016), Manifestly Haraway, ProQuest Ebook Central, University of Minnesota Press. http://ebookcentral.proquest.com/lib/warw/detail.action?docID+4392065.

MASSON-DELMOTTE, V., ZHAI, P., PÖRTNER, H.-O. et al. (IPCC) (in press) (2018), Summary for Policymakers. In: Global Warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

MOSTAFAVI, M. (2010), Why Ecological Urbanism? Why Now? In: MOSTAFAVI, M. & DOHERTY, G. (Eds.), Ecological Urbanism. Lars Muller Publishers, Baden, Switzerland.

READ, S. (2007), Thickening the surface – or, what is an 'ecological landscape'exactly? Kerb Journal, 15, 197-200.

WELLER, R. J. (2017), Précis. In: WELLER, R. J., HOCH, C. & HUANG, C. (Eds.), Atlas for the End of the World. http://atlas-for-the-end-of-the-world.com.

WELLER, R. J. (2019), An Introduction to Our Atlas for the Green New Deal. The 2100 Project: An Atlas for the Green New Deal. https://mcharg.upenn.edu/2100-project-atlas-green-new-deal#.