



Routledge Research in Sustainable Urbanism

REGENERATIVE URBAN DESIGN AND ECOSYSTEM BIOMIMICRY

Maibritt Pedersen Zari



Regenerative Urban Design and Ecosystem Biomimicry

It is clear that the climate is changing and ecosystems are becoming severely degraded. Humans must mitigate the causes of, and adapt to, climate change and the loss of biodiversity, as the impacts of these changes become more apparent and demand urgent responses. These pressures, combined with rapid global urbanisation and population growth, mean that new ways of designing, retrofitting and living in cities are critically needed. Incorporating an understanding of how the living world works and what ecosystems do into architectural and urban design is a step towards the creation and evolution of cities that are radically more sustainable and potentially regenerative. Can cities produce their own food, energy and water? Can they be designed to regulate climate, provide habitat, cycle nutrients and purify water, air and soil?

This book examines and defines the field of biomimicry for sustainable built environment design and goes on to translate ecological knowledge into practical methodologies for architectural and urban design that can proactively respond to climate change and biodiversity loss. These methods are tested and exemplified through a series of case studies of existing cities in a variety of climates.

Regenerative Urban Design and Ecosystem Biomimicry will be of great interest to students, professionals and researchers of architecture, urban design, ecology and environmental studies, as well as those interested in the interdisciplinary study of sustainability, ecology and urbanism.

Maibritt Pedersen Zari is a Senior Lecturer in Sustainable Architecture and Interior Architecture at Victoria University's School of Architecture, New Zealand. Her areas of expertise are biomimicry, biophilia, regenerative design and the practical intersection of ecology, climate change, and biodiversity loss with urban and architectural design.

Contents

<i>List of figures</i>	viii
<i>List of tables</i>	x
<i>Acknowledgements</i>	xi
1 A shift in architectural and urban design: cities as a medium of change	1
2 Incorporating biomimicry into regenerative design	16
3 Can built environment biomimicry address climate change?	44
4 Translating ecosystem processes into built environment design	69
5 Emulating ecosystem services in architectural and urban design: ecosystem services analysis	107
6 Applying ecosystem services biomimicry to urban contexts: city case studies (Wellington, Havana, Curitiba)	158
7 A wider context, reflection and evolution	233
<i>Index</i>	247

Figures

1.1	Drivers and results of change	2
1.2	Trajectory of regenerative design	4
1.3	Regenerative design impacts	6
2.1	Bio-inspired design terms	20
2.2	DaimlerChrysler's 2005 prototype bionic car (left); boxfish (right)	25
2.3	Davis Alpine House	26
2.4	Pangolin (left); Waterloo International Terminal (right)	31
2.5	Velcro life cycle compared to burr life cycle	33
3.1	CH2 Building	47
3.2	Moss Landing power plant (left); coral (right)	51
3.3	Time line of approaches to climate change mitigation and adaptation in the context of the built environment	63
4.1	Relationships between ecosystem processes	76
4.2	Fibonacci spiral in a nautilus shell (left); fractal pattern in tree branches (right)	79
4.3	Beaver dam (left); beaver (right)	81
4.4	Complexity vs. complicatedness	86
4.5	Ecosystem processes that contribute to resilience	98
4.6	Ecosystem processes that contribute to adaptability	99
4.7	Ecosystem processes that contribute to enhancing the capacity of the biosphere to support life	100
5.1	Relationships between ecosystem services and human wellbeing	108
5.2	Changes in global ecosystem areas between 1997 and 2011	110
5.3	Ecosystem services relationships diagram	115
5.4	Connections between climate regulation and other ecosystem services	117
5.5	Strong model of sustainability	118
5.6	Potential synergies and trade-offs between ecosystem services for a built environment context	133
5.7	Ecosystem services analysis process	142
6.1	Wellington, Havana and Curitiba land cover types	159
6.2	A conceptual depiction of trends in land cover transformation in colonised cities with particular emphasis on Wellington, Havana and Curitiba	162

6.3	Wellington, New Zealand; probable original forest (top right); current city (bottom right)	163
6.4	Havana, Cuba; original forest (bottom right); current city (bottom left)	165
6.5	Curitiba, Brazil; Atlantic rainforest (top right); current city (bottom right)	168
6.6	Carbon in Wellington, Havana and Curitiba	176
6.7	Amount of air pollution removed by trees in Wellington, Havana and Curitiba	181
6.8	Habitat in Wellington, Havana and Curitiba	187
6.9	Material flow targets for Wellington, Havana and Curitiba	193
6.10	Water and rainfall in Wellington, Havana and Curitiba	199
6.11	Energy and electricity in Wellington, Havana and Curitiba	208
6.12	Area of city and the provision of food for city residents	215
6.13	Pre-development, current and potential future ecosystem services provision for Wellington, Havana and Curitiba	217

Tables

2.1	Levels and dimensions of biomimicry: a framework for understanding biomimetic design	29
3.1	Direct climate change impacts on the built environment	56
3.2	Indirect climate change impacts on the built environment	58
4.1	Ecosystem processes list	73
4.2	Ecosystem process strategies and built environment design: climate change and biodiversity implications	92
5.1	Ecosystem services with reference to an urban context	112
5.2	Ranking of ecosystem services for consideration in a built environment context	131
5.3	Ecosystem services and built environment design: climate change and biodiversity implications	134
5.4	Ecosystem services and built environment design: design strategies and case studies	136
5.5	Ecosystem services analysis process, indicators and units – Steps 2(a), 2(b) and 3	143
6.1	Comparison of climate, population and ecology between Wellington, Havana and Curitiba	160
6.2	Electricity generation in Wellington, Havana and Curitiba	207
6.3	Comparison of pre-development, current and potential future ecosystem service provision in Wellington, Havana and Curitiba	218