



Green Roof Retrofit

Building Urban Resilience

Edited by Sara Wilkinson
and Tim Dixon

WILEY Blackwell

Green Roof Retrofit: Building Urban Resilience

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Foreword

When British Land first started creating green roofs on various London office buildings in 2004, it was challenging to take the idea from an ecologist's vision to the reality of a planted, healthy landscape. As a client, we were testing a new idea. We often needed to introduce our architects, structural engineers, contractors and property management partners to the concept – and then develop and test strategies together to deliver quality natural habitats on commercial buildings.

Over the years, as we have installed different green roof styles and commissioned studies, we have learned and shared many lessons. Today, we know more, for instance, about drainage and the potential for (or, more often, lack of) water retention. We understand the need for roof and terrace access to align with internal floor levels. We know which substrates last through British winters and how to plan for rooftop winds. We recognise issues and opportunities relating to visibility from surrounding buildings, and more. Happily, we have not been the only ones to recognise the benefits of green roofs and to learn these lessons.

Green roofs have gone mainstream around the world over the past 10 years. From London to Sydney, Hamburg to Istanbul, Singapore to Rio de Janeiro, they are a recognised strategy for urban green infrastructure. In London, there are now about 700 green roofs, covering 175,000 m². I am pleased that British Land has played a small but important part in this success story – creating green roofs on 12 new buildings and retrofitting three on existing buildings, with more on the way. Green roofs are no longer an unusual concept, and there are standard design formats and green roof types that architects and others understand and can design or install.

However, many of the technical benefits of green roofs remain to be analysed and understood. And so this book and the research it describes are much needed, particularly at a time when strengthening urban resilience is a critical policy issue.

Of particular relevance to cities and property owners are the prospects for retrofitting green roofs and the infrastructure benefits that all green roofs provide. Given the acres of existing roof space in cities around the world, what kind of buildings are particularly suitable for the additional structural load of retrofitting green roofs? With increasing incidence of flooding in many areas, how much rainwater can a 50 cm soil substrate attenuate, and can we make basement flood attenuation tanks correspondingly smaller? Also, how can we deliver green roofs that fulfil multiple functions, such as biodiversity, human enjoyment, aesthetics and food production?

Approaches to modelling urban heat island impacts are particularly useful for policy-makers. As climate change increasingly affects city temperatures, with knock-on effects on people's health and energy consumption, it is important to be able to calculate the benefit of green roofs for temperature management. Likewise, the proposed methodology for calculating the attenuation potential of green roofs should be of immediate assistance in factoring green roofs into strategies for our changing weather futures.

In addition, this book helpfully advances research on the social and biodiversity functions of green roofs for organisations interested in strategies to support human health, ecology and food production in urban areas. An in-depth analysis of a range of case studies explores how green roofs fulfil a range of functions – adding visual interest, creating garden spaces, growing food, introducing habitats for animal biodiversity and contributing to healthy environments through air-quality filtration, water management and temperature control. My colleagues are particularly interested in this social potential of green roofs. Following examples in the USA and Asia, we are exploring how to use our roof spaces to further promote people's health and wellbeing in the places we create.

I am delighted to recommend this book for its timely and substantial contribution to industry practice, and for improving our understanding of green roofs and their multiple benefits. The editors (Sara Wilkinson and Tim Dixon) have drawn together a diversity of authors to provide technical analysis of the practical and policy advantages of green roofs for cities facing climate change, with diverse case studies from Australia, the UK and Brazil. The research insights can also be tapped by property owners and designers to realise the commercial, social and environmental benefits of green roofs – from improving resource management in our cities to creating opportunities for bees, butterflies, birds and people to flourish in the built environment.

Green roofs have enormous potential in urban areas around the world. I hope that this book will aid cities and organisations in developing and growing acres of delightful and valuable habitats for people and the planet.

Sarah Cary
Head of Sustainable Places
British Land

Acknowledgements

Multidisciplinary projects are always challenging, exciting and fun, and working on this book together with our contributing authors has been no exception. The starting point was an increasing recognition that green roofs can really make an important difference in helping build ‘urban resilience’ (or the ability of our urban areas to be flexible and agile enough to bounce back from the anticipated and unanticipated environmental shocks stemming from rapid urbanisation, climate change and resource depletion). This is at the heart of the book, and is one of the key reasons so many cities globally are engaging with city-wide projects to green their environments – particularly so that they can adapt and mitigate for climate change.

The inspiration for this book arose from Sara Wilkinson’s membership of the City of Sydney Technical Advisory Panel from 2012 to 2014. During that time, Sara met with a multidisciplinary group of academics, practitioners and policy makers to work on ways to increase the uptake of green roofs within the City of Sydney. Lucy Sharman was the City of Sydney Green Roof & Green Walls Officer, and being a member of the group really raised awareness of the multiple benefits of green roofs. Sara wishes to thank Lucy for that. As a building surveyor she was well aware of the need to retrofit our urban environments, but being part of the group increased the belief that collectively, we can create and deliver change. Membership of the group led to a number of new and exciting green roof research collaborations and projects with mental healthcare professionals, disadvantaged groups and sustainable urban agriculture entrepreneurs. Sara wishes to thank the RICS Research Trust, City of Sydney and NSW Environmental Trust for funding some of that research, which features in this book. Sara still works with other academic members of the Technical Advisory Panel group, who have contributed to this book. The Technical Advisory Panel has evolved and broadened now into the National Green Infrastructure Network (NGIN), comprising academics and practitioners from several Australian universities and national research organisations as well as NSW state policy makers.

Writing a book is always a journey, and we were fortunate on this particular journey to have the company and wise counsel of a truly international and multidisciplinary group of 20 academics. The geographical spread of knowledge and expertise ranged from Brazil to the UK, Europe and Australia, covering a wide range of climates and temperature zones. We really wanted to create a resource that covered every type of green roof retrofit and as many professional, technical, legal and stakeholder aspects as possible. The

disciplines that have contributed include Building Surveying, Horticultural Science, Civil Engineering, Urban Planning, Architecture, Urbanism, Environmental Sustainability Consultancy, Entomology, Flood & Disaster Prevention Management, and Social Sciences. This is a rich and empowering environment in which to work, and we would like to thank all our contributing authors for their expertise and inputs to the text. This is the first book we are aware of that covers such a breadth of reasons to adopt green roofs from the retrofit perspective, and our aim is to facilitate the retrofit of greater numbers of green roofs as a result.

We also wish to personally thank the staff at Wiley Blackwell, Madeleine Metcalfe and Viktoria Vida for their support and help in delivering the book, and Sarah Cary of British Land for her foreword.

Finally, writing a book always takes time. Without the support and encouragement of family and friends the task would be much harder, so Sara would like to thank Ted, Ruskin, Maureen and Lindsay. Tim would also like to thank his family for all their help and support during the editing and writing process.

Sara Wilkinson and Tim Dixon

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1

Building Resilience in Urban Settlements Through Green Roof Retrofit

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1.0 Introduction

The ‘challenge of achieving sustainable development in the 21st century [will] be won or lost in the world’s urban areas’ (Newton and Bai, 2008: 4) and a major issue is the contribution that the built environment makes to greenhouse gas (GHG) emissions and global warming. Typically each year 1–2% of new buildings are added to the total stock; it follows that informed decision-making in respect of sustainable adaptation of existing stock is critical to deliver emissions reductions. Within cities, local government authorities are encouraging building adaptation to lower building-related energy consumption and associated GHG emissions. Examples include San Francisco in the USA and Melbourne in Australia. For example, the City of Melbourne aims to retrofit 1200 commercial central business district (CBD) properties before 2020 as part of their strategy to become carbon neutral (Lorenz and Lützkendorf, 2008). Office property contributes around 12% of all Australian GHG emissions and adaptation of this stock is a vital part of the policy (Garnaut, 2008). Whilst Australian cities date from the early 19th century, the concepts of adaptation and evolution of buildings and suburbs are not as well developed or entrenched as in other continents like Europe. However, the issue of the sustainable adaptation of existing stock is a universal problem, which increasing numbers of local and state

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