# UNMAKING WASTE IN PRODUCTION AND CONSUMPTION

## TOWARDS THE CIRCULAR ECONOMY

EDITED BY:
**ROBERT CROCKER, CHRISTOPHER SAINT, GUANYI CHEN AND YINDONG TONG**

# UNMAKING WASTE IN PRODUCTION AND CONSUMPTION

*This page intentionally left blank*

# UNMAKING WASTE IN PRODUCTION AND CONSUMPTION: TOWARDS THE CIRCULAR ECONOMY

EDITED BY

**ROBERT CROCKER, CHRISTOPHER SAINT, GUANYI CHEN AND YINDONG TONG**


United Kingdom – North America – Japan – India – Malaysia – China

Emerald Publishing Limited
Howard House, Wagon Lane, Bingley BD16 1WA, UK

First edition 2018



**British Library Cataloguing in Publication Data**
A catalogue record for this book is available from the British Library

ISBN: 978-1-78714-620-4 (Print)
ISBN: 978-1-78714-619-8 (Online)
ISBN: 978-1-78714-996-0 (Epub)


ISOQAR certified Management System, awarded to Emerald for adherence to Environmental standard ISO 14001:2004.

Certificate Number 1985
ISO 14001

INVESTOR IN PEOPLE

# Contents

**Part II: Consumption, Design and Behaviour**



**Part III: Waste and Resource Recovery**

**Part IV: Technology and Systems Innovation**

# List of Figures

# List of Tables

# Preface

# Unmaking Waste in Production and Consumption: Towards the Circular Economy

*Li'an Hou*

The annual *Living Planet Report* released by the World Wide Fund for Nature (WWF) and the International Non-Governmental Organisation (INGO) Global Footprint Network revealed that 'Earth Overshoot Day', the day on which humanity starts using more ecological services and resources than the earth can generate, is again ahead of schedule.[1] The 2017 Earth Overshoot Day was August 2, 28 days earlier than 10 years ago, and 67 days earlier than 20 years ago. Facing our current situation of resource shortages and environmental pollution, the linear economic road of 'make-use-waste' has been difficult to maintain, and the circular economy of 'make-use-renew' has become an inevitable choice, to promote the recycling of limited resources, so as to make human society sustainable.

The circular economy requires a fundamental change to the traditional economic model of mass production, increasing consumption and ever larger amounts of waste. From the technical perspective of resource utilisation, the circular economy is to be realised mainly through three means: the efficient utilisation of resources, the recycling of resources through the economy and harmless production. The circular economy is based on resource reuse to achieve sustainable economic growth, which is obviously better than the traditional linear economy, which has relied on the destruction of the natural environment in exchange for short-term economic growth. The development of the circular economy thus not only reduces the waste of resources, but also represents a significant new development model.

In recent years, the economic and environmental costs of traditional ways of developing resources have steadily increased. Some countries have begun to mine deep-sea resources, searching for these deep below the surface of the earth and ocean, and even trying to discover resources in outer space. However, finding these increasingly distant resources, or other alternatives, is not the only way to solve our resource crisis. The circular economy advocates the recycling of raw materials, rather than the continuing pursuit of new resources, as a way of meeting the larger needs of social development.

If the search for new resources involves a kind of 'addition' to economic activity, but one dependent on consuming more resources, then the circular economy involves a 'multiplication' of this activity, but one requiring less resources, and

thus less environmental impact. The development of the circular economy is thus the only way to achieve social and economic development before sufficient alternative resources can be found. After years of practice, it has been shown that the production and development model of the circular economy is of great significance to business, environment and society. Facing increasingly tighter resource constraints, 'Unmaking Waste in Production and Consumption: Towards the Circular Economy' becomes an important pathway to implementing the circular economy for the new era.

This book is based on research from both developing and developed countries. Through interdisciplinary exchanges, discussions and studies, it analyses the concept of the circular economy, emphasizing the different contexts in which the circulation of materials through the economy takes place. It presents some unique views on the theory and practice of the circular economy, and embodies some remarkable achievements in the study of its application.

The first half of the book mainly interprets the past and present of the circular economy, at a more theoretical and policy level. This part, starting with the flow of raw materials and the efficiency of resources, explores the internal law and operating mechanism of the circular economy in the light of the consumption of goods and services. The second half focusses on the impact of the circular economy concept on technology and design, from the perspective of enterprise, environment and society and suggests ways in which the circular economy can be applied in new and traditional industries, from the macro level.

The book's authors include dozens of scholars from around the world who have collaborated to develop new insights into the circular economy and its application. In this book, you can find both scientific and reliable firsthand survey data, but also find profound theoretical analysis and research on this developing model for a sustainable future. It can be used as a reference for both researchers and decision-makers, as well as for ordinary readers concerned about how the problems of resource overconsumption and environmental damage might best be solved through the implementation of the circular economy. This book is timely, a valuable contribution to academic and scientific work on this vital topic.

(Translated from Chinese by Dr. Na Ji.)

## Note

1. Initially started on December 31 in 1986, Earth Overshoot Day has been moving forward ever since. See: https://www.overshootday.org.

# About the Contributors

**Jen Ballie's** research is design-led and focussed upon social innovation and sustainability. Her PhD, 'e-Co-Textile DESIGN' applied the concept of 'fashion activism' to textile design and making, to pilot alternative fast fashion models for sustainability. Jen is currently the Design for Business Research Manager at the Victoria & Albert Dundee Design Museum.

**Nanthi S. Bolan** is a Professor based at the Global Centre for Environmental Remediation, University of Newcastle. He has had an illustrious career in soil science, having published more than 200 papers. He was awarded the M.L. Leamy Award in recognition of his contributions to soil science. His research interests include soil fertility and waste remediation.

**Guanyi Chen** is Professor and Dean of the School of Environmental Science and Technology, Tianjin University and the Director of the China Australia Centre for Sustainable Urban Development. His research focusses on bio-energy utilisation and thermal-chemical conversion.

**Hélène Cherrier** completed her PhD at the University of Arkansas on disposal and identity in the context of downshifting and simple living. Hélène's interests focus on bringing about a more sustainable and just society. This influences her current research on poverty alleviation, waste value, social and environmental activism and object relations.

**Nicholas Chileshe** is an Associate Professor in Construction and Project Management in the School of Natural and Built Environments at the University of South Australia. He is Research Education and Portfolio Leader and Programme Director responsible for the Doctorate in Project Management. Nicholas obtained his PhD in Construction Management from Sheffield Hallam University in 2004.

**Robert Crocker** is Deputy Director of the China Australia Centre for Sustainable Urban Development in the School of Art, Architecture and Design at the University of South Australia. With a background in history, his research focusses on the role of consumption and waste in our environmental crisis. His most recent book was *Somebody Else's Problem: Consumerism, sustainability and design* (Greenleaf, 2016).

**Philip Crowther** is an Associate Professor at the Queensland University of Technology. He has qualifications in architecture, film and higher education. He has written many papers on construction technology and embodied energy.

A registered architect in Queensland, he has worked on numerous architecture projects in Australia and China

**Huiping Cui** is a Postgraduate Student in Environmental Science and Engineering, Tianjin University. Her research interests include urban runoff pollution control, urban water quality improvement, storm water management modelling and water quality analysis simulation. Her graduation thesis was 'Study on Compound Pollution Controlling of Rainwater System in an Industrial Park'.

**Zeng Dan** is an Associate Professor in the Department of Chemistry and Environment Science in the School of Science, Tibet University. He is also a PhD candidate at Tianjin University. His recent work focusses on Municipal Solid Waste treatment, utilisation and pollution control on the Tibet plateau.

**Claudia A. Echeverria** is an Architect and Landscape Architect. She is currently a PhD candidate at the SMaRT Centre, University of New South Wales. Her research focusses on architectural biotechnology with waste fibres, and the recovery of diverse fibre waste materials for the advancement and development of novel low-carbon bio-composite materials, as well as non-fibre high-end applications.

**Abbas Elmualim** is Professor in Construction and Project Management at University of South Australia and is Strand Leader for Sustainable Infrastructure and Built Environments there. He was previously at the School of Construction Management and Engineering, the University of Reading, UK, and one of the leaders of the £3.5 m EPSRC funded Innovative Construction Research Centre (ICRC), Reading.

**Simon Fraser** is Professor of Industrial Design at the School of Design, Victoria University of Wellington in New Zealand. He has a long track record of practice based research in both industry and academia. His research focusses on additive manufacturing and includes new applications of digital tools and methods for designing and more inclusive platforms of production through virtual systems, services and networks.

**Jacob Fry** is a Post-Doctoral Research Associate with the ISA group at the School of Physics, University of Sydney. His PhD focused on waste and material flows, and multi-scale input-output analysis. Jacob also works in commercial building energy efficiency for BUENO systems.

**Damien Giurco** is Professor of Resource Futures at the Institute for Sustainable Futures, University of Technology Sydney. His work with government and industry focuses on resource stewardship and he directs the Wealth from Waste Cluster supporting circular economy pathways and policies for metals. He is Editor-in-Chief of the journal, *Resources*.

**Norman Goh** is a completing PhD candidate at the University of South Australia with a background in Chemical Engineering and Wastewater Treatment Systems. Norman's interest in biosolids and environmental policy has seen him awarded the 2017 Student Excellence Award for commitment to the progression of biosolids research by the Australian and New Zealand Biosolids Partnership.

**Wayne Gumley** is a Senior Lecturer in law at Monash Business School. Wayne's research interests include environmental law, corporate social responsibility, taxation and administrative law. His recent projects include regulatory strategies for the management of e-waste, a review of Victorian legislation on hazardous waste and an international project on wildlife conservation.

**Li'an Hou** is an Academician of the Chinese Academy of Engineering, and a widely respected expert in environmental engineering. One of the pioneers of prevention and control technologies for pollution in China, he first proposed and successfully developed advanced techniques and equipment for ensuring water quality, domestic sewage treatment and air purification for human settlements.

**Singh Intrachooto** is Associate Professor of Building Innovation, architect and design principal of OSISU, Thailand's leading eco-design venture. He is the founder of Scrap Lab and Head of the Creative Center for Eco-design, a design research centre focusing on upcycling at Kasetsart University Architecture as well as Director of Research & Innovation for Sustainability Center (RISC) at MQDC Limited, Bangkok, Thailand. He holds a PhD in Design Technology (Architecture) from MIT.

**Min Ji** is a Professor of Environmental Engineering, and the Director of Tianjin Engineering Research Centre of Urban River Eco-Purification Technology. His research interests include: theory and technology in wastewater treatment and management, planning and control of urban water environments and urban runoff pollution anaerobic sludge digestion and bioenergy technology.

**Marcia Kreinhold** is the Director, Business at Green Industries SA where she is responsible for delivering projects which reinforce South Australia's reputation for leadership and innovation in the green economy. Her work in the area of evidence-based social marketing has been internationally recognised.

**Ruth Lane** is a Human Geographer in the School of Social Sciences at Monash University. Her research focusses on intersections between social change, environmental degradation and environmental governance. She has examined this through studies of the consumption of goods and materials, and associated issues of waste, reuse and materials recycling.

**Manfred Lenzen** is Professor of Sustainability Research at the School of Physics, University of Sydney. He has a PhD in Physics and his current research interests focus on the link between environmental/resource impacts and international trade, leading the development of cloud-based collaborative platforms for building large-scale global economic-environmental models that enable environmental impact analysis across global supply-chain networks. He is the Editor-in-Chief of the journal *Economic Systems Research.*

**Tat Ho Leung** is a Research Associate at the Sustainable Real Estate Research Center, Hong Kong Shue Yan University. Recently his research has focussed on real estate, housing policy and construction safety, which are mainly

government-funded projects. His latest co-authored book is *Econometric Analysis of International Housing Market*.

**Vaughan Levitzke**, PSM, is the Chief Executive of Green Industries SA (GISA) a State Government statutory corporation. He was formerly Chief Executive of Zero Waste SA, GISA's predecessor organisation. GISA provides incentives and develops policies to enhance and improve circular economy outcomes and achieve sustainable development goals.

**Rita Yi Man Li** now serves as an Associate Professor in the Department of Economics and Finance, Hong Kong Shue Yan University (HKSYU). She is the founder and director of the Sustainable Real Estate Research Center and the HKSYU Real Estate and Economics Research Lab. She has written more than 200 articles.

**Kerry London** is the Deputy Dean and Professor of Built Environment and Urban Transformation in Western Sydney University. Prior to this Kerry held the position of Dean of Research and Innovation in the Division of Education, Arts and Social Sciences at the University of South Australia. She is an ARC College of Experts Panel Member for the Humanities and Creative Arts.

**Xuebin Lu** is an Associate Professor in the School of Environmental Science and Technology, Tianjin University. He obtained his PhD from Tianjin University in 2009 and worked as a joint PhD student in Technical university of Denmark from 2007 to 2008. His recent work focusses on lignocellulose waste materials utilisation.

**Wenchao Ma** lectures in the School of Environmental Science and Technology, Tianjin University. She obtained her PhD from Tianjin University in 2010 and worked as a joint PhD student in TU Berlin from 2006 to 2008. Her recent work focusses on solid waste utilisation and plasma gasification.

**Samane Maroufi** holds both a Bachelor's and Master's Degree in Chemical Engineering and a PhD in Materials Science and Engineering from the University of New South Wales. She joined the SMaRT Centre there in 2015 as a research associate working on the use of non-traditional waste materials in iron and steelmaking industries, and the transformation of e-waste into value-added nanoproducts.

**Kirsty Máté** is a Senior Lecturer and the Program Director of Interior Design, University of Tasmania. Kirsty has over 25 years of experience in education, research and practice in sustainable design, particularly for the commercial sector. Currently completing a PhD at UTAS, her thesis focusses on the impact new forms of sustainable consumerism will have on the design of shopping 'scapes'.

**Li Meng** is a Research Fellow at the University of South Australia. Li's main research interest is to utilise discrete choice models and stated preference data to analyse travel behaviour change. Li's current research covers four areas: integrated transport and land use planning, choice experiment design for green city travel, shared mobility and integrated infrastructure planning and supply chain management.

**Tim McGinley** has practised architecture in the UK and Europe. He now lectures in architecture and digital design at the University of South Australia. His research aims to support a collaborative design experience that intersects biology,

computation and design. In 2015 he co-founded the Morphogenetic Prototyping Lab and Agile X Research Group.

**Sherif Mostafa** is a Lecturer in Construction and Engineering Project Management at Griffith University. He is leading, developing, coordinating, and lecturing construction and project management subjects. Sherif's areas of expertise include Lean-Six-Sigma and BIM integration within prefabricated buildings, advanced technologies in offsite construction and dynamic simulation of engineering systems.

**Jeongbin Ok** is a Senior Lecturer in Industrial Design at Victoria University of Wellington in New Zealand. His research interests span design for safety, health and sustainability through the adaptive integration of technologies including smart materials, additive manufacturing and digital processes. He is an inventor of more than 20 patented materials, systems and products.

**Nil Özçağlar-Toulouse** is Professor of Marketing at the University of Lille and SKEMA Business School in France. He researches theoretical issues in consumer culture theory, including consumer resistance, ethical consumption, acculturation, identity projects and also social marketing and public policy implications, for example on immigration, fair trade and sustainable development.

**Stefan Pauliuk** is an expert in method development to assess sustainable development strategies. He works with supply chain analysis and scenario modelling for sustainable material futures. He is an assistant professor for sustainable material and energy flow management at the Faculty for Environment and Natural Resources, University of Freiburg, Germany.

**Farshid Pahlevani** is an authority on high temperature metallurgical processes who has made a considerable contribution to the understanding of the behaviour of metallic materials at high temperatures and their interactions with other elements. Since his appointment at the SMaRT Centre in UNSW, he has made considerable progress in incorporating waste into the manufacture of green materials.

**Sen Peng** is an Associate Professor in the School of Environmental Science and Engineering, Tianjin University. He completed his PhD on the uncertainty of water quality modelling based on WASP models. His research focusses on environmental system simulation and optimisation, municipal pipe network systems, surface water environment modelling and its uncertainty.

**Raufdeen Rameezdeen** is the Associate Head of School (Programs) at the School of Natural and Built Environments, University of South Australia. He is interested in sustainability, waste management and occupational health and safety issues related to the construction industry. Raufdeen is an active member of the Australian Institute of Quantity Surveyors and the Royal Institution of Chartered Surveyors.

**Veena Sahajwalla** is an ARC Laureate Professor, revolutionizing recycling science to unlock the resources embedded in wastes now destined for landfill. As a founding Director of the Centre for Sustainable Materials Research and Technology

(SMaRT) at the University of New South Wales, she is producing a new generation of green materials, products and resources made entirely, or primarily, from waste.

**Christopher P. Saint** is the Director of the China Australia Centre for Sustainable Urban Development, and Dean, Research and Innovation, of the Information Technology, Engineering and the Environment Division at the University of South Australia. He is a microbiologist with 30 years' experience in environmental science and the water industry, and has published over 150 scientific papers.

**Martin Shanahan** is Professor of Economic and Business History at the University of South Australia. He has published in the fields of climate change adaptation, water markets, the history of cartels and wealth distribution among others. His work attempts to use the lessons of history to inform present debates.

**Anne Sharp** is at the Ehrenberg-Bass Institute, University of South Australia. All Anne's work has the common theme of applying marketing science knowledge to sustainable marketing. Anne has published over 50 academic refereed papers and book chapters.

**Michael D. Short** is a Senior Research Fellow at the School of Natural and Built Environments, University of South Australia. Michael's expertise is in urban water systems, environmental microbiology and aquatic ecology, sustainability assessment and life cycle assessment and the intersection of environmental science and policy.

**Lara Stocchi** is at the College of Business, Government and Law, Flinders University. Her main area of research focus is the link between consumer buying behaviour and memory. Her work is published in several academic journals and has been presented at many international marketing conferences.

**Lionel Taito-Matamua** is a Social Entrepreneur and Educator researching the design and 3D printing-based recycling of plastic waste in the Pacific through local communities in the region. As a Co-founder of Creative Pathways outreach, he develops and runs programmes aimed at providing STEM and design subjects for schools and communities, with a specific focus on Pacific, Māori and females.

**Yindong Tong** is Deputy Director of the China Australia Centre for Sustainable Urban Development, and Associate Professor of environmental science at the School of Environmental Science and Engineering, Tianjin University. His research focusses on sustainable water planning, and impact analysis of human activities on water quality. He has published over 40 scientific papers in this field.

**Meltem Türe** received her PhD in Marketing from Bilkent University in Turkey in 2013. She is currently working at Skema Business School – Universite Lille in France as an assistant Professor of marketing. She conducts research in object disposal and sustainability, materialism, ethics and moral consumption, value and value co-creation and health and food consumption.

**Yuan Wang** is a Professor at Tianjin University. She has qualifications in environmental management and planning. She has written many papers on air

pollution and carbon. She has worked on numerous environmental planning projects in China.

**Mel Woods** is Reader at the University of Dundee where she develops highly collaborative and interdisciplinary approaches to research in the Creative and Digital Economy. A central research interest is in designing for creative intelligence with a focus on people, future technologies, societal challenges and change-making.

**Xu Zhao** earned his PhD in Civil Engineering from The University of Western Australia in 2014, before he joined the China Australia Centre for Sustainable Urban Development at Tianjin University. Since July 2016, he has been conducting sustainability-related research at Tianjin Research Institute for Water Transport Engineering, Ministry of Transport, China.

**Jian Zuo** is an Associate Professor in the School of Architecture and Built Environment at the University of Adelaide. His main research interest is achieving a sustainable built environment through stakeholder engagement. He has published extensively in international journals and conferences in this field of research.