Abdelnaser Omran
Odile Schwarz-Herion *Editors*

Sustaining our Environment for Better Future

Challenges and Opportunities

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Editors
Abdelnaser Omran
Faculty of Engineering Sciences
Bright Star University
El-brega, Libya

Odile Schwarz-Herion
Dres. Schwarz-Herion KG Detective Agency
Ettlingen, Baden-Württemberg, Germany

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Preface

Sustaining our environment is the major theme of the book. It provides a foundation for understanding how our unsuspecting practices and activities such as improper waste disposal, polluting water by dumping waste into rivers, littering on the sidewalk, or even in wells or streams, smoke generated by cars and other motor vehicles, burning rubbish, deforestation, etc., in fact, all such unacceptable practices, have harmed the environment in many ways and caused several negative impacts on our lives, natural resources like water, agriculture and food, as well as tourism, etc., many of which are ultimately deemed to be the main reason for climate change by some well-known scholars in the environmental and sustainability sectors.

This book was written to help people make sense of the discussion on how to sustain our environment for a better future through the challenges that their respective countries or cities faced or are facing and what would be the best strategies to mitigate, reduce or even entirely eliminate all threats and damages to create a sustainable environment for our new generation. In particular, we focus on the question of whether or not we can solve the problems we are currently facing. At the moment, it may seem easy to simply justify and accept that our climate has changed and that it will further change due to our unacceptable practices without bringing any useful and sustainable solutions into place.

In reality, there are many ways to change our current practices and methods for the better by finding reasonable solutions, but serious efforts need to be established in order to make that possible. Some people believe that the only option is to change our lifestyle by referring to international experiences and by adopting their solutions in handling such matters. However, that could be an acceptable way in the short term, but to deal with the long-term issue of climate change, there must be other alternatives and larger solutions to what we are facing currently. Perhaps, one of these solutions could be revising existing policies and strategies or modifying some of the imposed regulations and strengthening the involvement of the government and their framework for better practices. Some people also believe that technology will give us abundant CO_2-free energy at low cost in the near future.

This book consists of 13 chapters.

Chapter 1 focuses on the juxtaposition of neoclassical economy and sustainable economy. The author starts with the hypothesis that all scientific disciplines including engineering and natural sciences, the humanities and social sciences, and other scientific disciplines are characterized by various dynamics under continuous development and that scientific progress will only take place if young scientists know and do everything the older scientific generations have known and add new knowledge and incremental skills to this. Over the course of the chapter, the author reveals the kind of controversies that have emerged between different scientific discourses within economics due to strongly diverging patterns of reasoning and assessments, such as those between the representatives of neoclassical theory, on the one hand, and those of ecological economics, on the other. Controversies can not only result from different definitions of technical terms like, for example, "steady-state economy", but also due to the inclusion or omission of certain factors as, for example, non-renewable resources. Chapter 2 looks at mining disasters in recent years, for example, two dramatic mining disasters that occurred in Latin America over the last few years. In August 2014, a copper mine owned by Buenavista del Cobre, a subsidiary of Grupo Mexico spilled 10.5 million gallons of copper sulphate acid into Mexico's public waterways. In November 2015, in the state of Minas Gerais, Brazil, the Fundão tailings dam burst at an open pit mine operated by Samarco, and another dam ruptured, sending a wave of chemically hazardous sludge throughout nearby regions, killing 20 people, causing enormous social, environmental, and economic damage. Taking these disasters as case studies, this chapter reviews the failures of the mining industry in Latin America, including human failures, partly based on gross negligence, partly on conditional intent due to inertia, indifference toward the natural environment, safety, and even human life, coupled with human greed, which led to these disasters. Towards the end of this chapter, the authors offer some suggestions on how to prevent such disasters in the future. Chapter 3 investigates the challenges and opportunities which people face with regard to rural development in Africa. The main essence is to transform rural societies into contemporary communities, and the prime goal is to alleviate poverty and further lessen the continuous migration of people from rural to urban areas, who penetrate every nook and cranny of urban cities in search of a better means of livelihood. Chapter 4 attempts to develop planning for the renowned tourism destination Acapulco in Mexico. The authors introduce Sharpley's model. The chosen methodological approach is explained and the model is then applied to Acapulco to examine its appropriateness as a framework for development planning. In Chap. 5, the authors examine women's involvement in environmental management with particular reference to the Gaza Strip, Palestine. Recent years have shown a deterioration in the livelihood due to many factors, such as poor environmental practices and resource management leading to environmental degradation with increasing migration of men to urban areas, resulting in extra workload on women in rural areas. Chapter 6 discusses drinking water contamination as a primary health concern in the present world. It aims to address the mass poisoning issue which has created severe diseases in population of all ages. An overview of steps presently taken by the government has also been given under this discussion. Besides, some proposed solutions, such as legislative controls, governance, up-to-the-mark sewerage system, treatment of industrial wastes, and anti-water-pollution rules and regulations are also recommended. Chapter 7 discusses the challenges to the irrigation water-energy nexus in Australia. The case studies presented in this chapter focus on Queensland and New South Wales, showcasing the challenges of Australia's agricultural producers in reconciling their water and energy requirements whilst producing high-quality food and fibre. The case studies illustrate how uncoordinated State and Federal government policies are undermining sustainable agricultural practices in Australia and impacting the broader environment. The authors also outline how agricultural producers are progressively tackling the energy-water-food nexus challenges through innovative thinking and collaborative engagement between different stakeholders. In Chap. 8, the author discusses the importance of agricultural soils in Queensland and some specific challenges, and outlines the risks and opportunities from the State's emerging bioeconomy industry and returning nutrients to soil as part of a circular economy approach. Chapter 9 highlights what is needed to be done for our future generations to create a sustainable mechanism that is green, scalable, and secure for the way we develop and obtain energy from a purely economic perspective. In Chap. 10, the authors aim to assess the inclination towards sustainable consumption among Romanian students, using the young consumers' sustainable consumption behaviour (YCSCB) scale pertaining to two aspects, food and clothing, a scale developed by Daniel Fischer and his colleagues in 2017. Chapter 11 takes into account the fact that forests acting as natural CO_2 sinks while releasing O_2 into the atmosphere via the photosythesis are the lungs of the planet and have a role in maintaining sustainability on earth providing abundant benefits for human life and supporting life on earth for all habitats that make up the ecosystem. The authors evaluate the current practices of deforestation with a focus on Asia – particularly Malaysia, also looking at the causes and effects of deforestation. In Chap. 12, the authors aim at examining the impact of Sustainability Risk Management (SRM) practices on the survival of environmentally sensitive companies in Malaysia. Sustainability risk management (SRM) is a process that systematically integrates environmental, social, and economic factors to manage the effects of sustainability risk on a company's survival, while meeting stakeholder needs. A case study carried out on environmentally and socially conscious companies in three sectors shows that leadership and compliance are considered important factors in implementing the SRM programme. The study also sheds light on other factors associated with successful SRM practices – namely sound risk culture, adequate risk management tools, and effective business continuity planning. Chapter 13 discusses the role of Smart Cities in the framework of the UN Sustainable Development Goals (SDGs) in a dialectic way. Promoted as "green" and inclusive cities, Smart Cities are reportedly facilitating the implementation of the UN Sustainable Development Goals (SDGs) by Smart Grids, the Internet of Things (IoT), Big Data, Algorithms, and Artificial Intelligence (AI) to optimize energy efficiency, water safety, food safety, and to ensure a high quality of life while offering great opportunities for multicultural cross-fertilization, supposedly offering citizens a clean, safe, friendly, and pluralistic social environment. Nevertheless, the numerous high-tech devices applied in highly digitalized Smart Cities may ultimately consume more energy and materials than they actually save – in addition to creating huge heaps of electronic waste and health-threatening electro-smog. Finally, it depends on various factors including a wise use of digital technology, an appropriate but payable Smart City infrastructure, as well as efficient and economic traffic connections between Smart Cities and rural areas in how far Smart Cities are generally capable of supporting at least some of the SDGs.

Elbrega, Libya Abdelnaser Omran

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Last but not least, I cannot forget my three beautiful children, Yara, Yusra, and Yazeed, who have been very patient with me.

Elbrega, Libya — Abdelnaser Omran

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Editors and Contributors

About the Editors

Dr. Abdelnaser Omran is currently working at the Faculty of Engineering Sciences under Bright Star University in Libya. He has written widely on environmental engineering and waste management issues in Africa, Asia, and Europe and he has also contributed many other publications in the field of project and construction management, sustainable-development-related issues, and risk management. So far, he has published more than 250 articles in international journals and proceedings papers at local and international conferences. Besides, he has written seven books. He served as an international reviewer and an editorial member for quite a number of international journals, and he also served as scientific committee member for many local and international conferences and seminars.

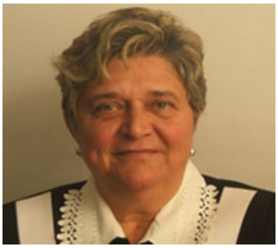
Dr. Odile Schwarz-Herion studied law (majors criminology and criminalistics) in Freiburg i.Br. and industrial engineering, including advanced manufacturing and IT, as well as economic sciences in Stuttgart. Her university degrees include an MBA from the Stuttgart Institute of Management and Technology (S.I.M.T.) as well as a PhD in economic sciences with a focus on sustainable development from the University of Hohenheim in 2005. During and after her studies, Schwarz-Herion worked as a sales engineer in large international companies and later on as an SD consultant, also acting as a plenary keynote speaker and round table chairperson at international sustainability conferences. In 2011, the ZAD-certified private detective Schwarz-Herion, who is also holder of the comprehensive state security license, founded Dres. Schwarz-Herion KG Detektei, a private detective agency specializing in crime investigation, including environmental crimes and white-collar crime. In 2015, Schwarz-Herion joined the World Association of Detectives (W.A.D.) and was elected as a designated director to the W.A.D. board in 2016. Schwarz-Herion is author and editor of several books and journal articles about SD, economics, international politics, innovative technologies, and crime investigation.

Authors

Prof. Mohammed Ahmed Ali is a lecturer at the Department of Agricultural Engineering, Faculty of Agricultural Sciences from the University of Gezira in Sudan. In 1976, he was awarded an MSc from Iowa State University, USA, in the field of power and machinery, and a BSc from the University of Khartoum in 1970.

Dr. Nazliatul Aniza Abdul Aziz is currently a lecturer in the Department of Banking and Risk Management, School of Economics, Finance and Banking (SEFB), College of Business (COB), Universiti Utara, Malaysia. She received her PhD in sustainability risk management from the Universiti Utara, Malaysia in 2018. Her main research interests include enterprise risk management, sustainability risk management, and Islamic insurance.

Dr. Dumitru-Alexandru Bodislav is a lecturer at the Economics and Economic Policy Department of the Bucharest University of Economic Studies. He participated in numerous online and onsite courses and seminars at Harvard Business School, Columbia Business School, Michigan University, IBM, and Microsoft. For his postdoctoral fellowship, he researched the Big Data–Business Intelligence synergy and its influence on socio-economic indicators for creating better government measures. He has also published and presented more than 130 research papers worldwide. Bodislav has authored or co-authored several books published in the USA and Europe, some of them bestsellers in their domains, especially the one published by Palgrave Macmillan.



Dr. Florina Bran is a professor at the Bucharest University of Economic Studies, at the Department of Agro-Food and Environmental Economics. She is a PhD tutor for more than 12 years and acted as vice dean for the Faculty of Agro-Food and Environmental Economics. During her tenure at BUES she has developed several courses for undergraduate, graduate and doctoral levels. Her skills promoted her as chair of various commissions for organizing international scientific events. Bran has received several awards such as Professor Emeritus, Doctor Honoris Causa, Excellency Award and the honour of being a visiting professor at Partherope University of Naples (Italy). Bran has published more than 50 books and over 200 articles as author or co-author.

Dr. Jennifer Brown is a Policy Officer at Cotton Australia. This is the key representative body for Australia's cotton growing industry, supporting about 1200 cotton farming families across 152 regional communities in New South Wales, Queensland, and now into Victoria. In her work with Cotton Australia, Brown focuses on energy and environmental management to foster policies that reflect growers' needs. She represents Cotton Australia's interests nationally via agricultural industry bodies as well as engaging industry organizations and government, primarily across New South Wales and Queensland. Brown holds a Bachelor of Applied Science (Systems) Agriculture (1989), a

Master of Environmental Management (1999) and a Master of International Environmental Law (2007). In her work prior to Cotton Australia, Brown pursued roles that explored the nexus between agriculture and the environment, typically working on sustainability issues, involving policy, and advocacy.

Dr. Georgina Davis is a Chartered Waste Manager and Chartered Environmentalist (CEnv) with 25 years' international experience. She is the Founder of the Waste to Opportunity Enterprise and holds an Adjunct position at Griffith University, Brisbane, Australia. She provides policy advice to Queensland's peak farming body, the Queensland Farmers' Federation (QFF) and its member organizations; linking opportunities in current government policy to operational issues impacting the agricultural sector, and providing advocacy where required. Davis further contributes as a Board Member of the Waste Management Association of Australia (WMAA) and the Queensland Great Artesian Basin Advisory Council (QGABAC) and is a Commissioner of Declarations.

Prof. Dr. Elena Druică is Full Professor of statistics for business, applied econometrics and data analysis with the University of Bucharest. She was formally trained in mathematics, completing her PhD in 2003. During her PhD, she studied genetic algorithms and optimization processes, developing a new classification of objective functions that converge to the optimum in polynomial time. During her second doctoral work, she studied Economics with a particular focus on risk assessment, and she now applies her skills in the area of saving behaviour, implementing agent-based modelling to explain peer pressure influence on economic rationality. Druică is interested in agent-based modelling and uses Net Logo to simulate various social and economic phenomena and is also skilled in using statistical and econometric methods to deal with real data for both descriptive and predictive purposes. She is trained in R programming language.

Dr. Alejandro Díaz Garay is the co-ordinator of the Autonomous University of Guerrero's MSc programme "Sustainable Tourism Management". He holds a bachelor's degree in Economics, which he obtained at Mexico's Autonomous Metropolitan University, a master's degree in Social Sciences from the Autonomous University of Guerrero and a PhD in Geography from the National Autonomous University of Mexico. He has 27 years of teaching experience in the field of social sciences and his area of expertise lies in international migration and sustainable tourism development. He has published a number of high-quality journal articles, edited 13 books and has also contributed to 24 book chapters. Furthermore, he has completed several funded research projects related to Mexico-US migration and sustainable tourism development and acted as supervisor to many other projects. Currently, he is conducting a project which explores various problematic issues that occur when Acapulco becomes saturated due to elevated demand during Mexico's Easter, summer, and Christmas vacation periods.

Assoc. Prof. Dr. Rodica Ianole-Călin is Associate Professor at the Faculty of Business and Administration, University of Bucharest, Romania. She holds a PhD in Behavioural Economics, a master's degree in Economic Cybernetics and Quantitative Economics and a bachelor's degree in Business Administration. Her professional training is complemented by multiple international courses, research stages, and summer schools (the Netherlands, Germany, Belgium, Italy, Russia, USA). Ianole-Călin's teaching expertise covers Microeconomics, Data Analysis, Game Theory, and Behavioral Economics, while her research interests include also Complexity Economics and Agent-Based Modelling. She currently serves as Editor-in-Chief of the *International Journal of Applied Behavioral Economics*, published by IGI Global, USA.

Mr. Hafiz Waqas Kamran holds an MPhil, majoring in Finance, and was working as Head of Finance and lecturer at the University of Central Punjab UCP Faisalabad, Pakistan. He has a teaching experience of 6.½ years. Kamran is currently pursuing his PhD specializing in Finance (Risk Management) at the School of Economics, Finance and Banking, Universiti Utara Malaysia. He has 20 research publications and good command in STATA-14, SPSS AMOS Graphics 21, R-Studio, and Eviews.

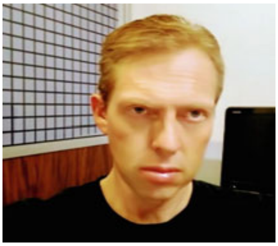
Assoc. Prof. Dr. Magdalena Rădulescu is Associate Professor of Banking at the University of Pitesti, Department of Finance and Accounting, Romania. She holds a PhD, a postdoctoral degree, and a habilitation degree in Economics. Her research interests cover financial and banking management, financial macroeconomics, risk management, and foreign investments. Her academic records include journal and conference papers, book chapters, and project reports.

Assoc. Prof. Dr. Norlida Abdul Manab is currently Associate Professor in the field of risk management at the Department of Banking and Risk Management, School of Economics, Finance and Banking, College of Business, Universiti Utara Malaysia. Her main research interests include enterprise risk management, financial risk management, corporate governance, and other issues related to risk management. She is actively involved in teaching and supervising PhD students in the area of risk management and insurance.

Dr. Carmen Valentina Rădulescu is Associate Professor at the Bucharest University of Economic Studies, at the Department of Agro-Food and Environmental Economics. She is a PhD tutor since 2017 for the Faculty of Agro-Food and Environmental Economics. During her tenure at BUES, she developed several courses for graduate and undergraduate levels. Her skills promoted her as chair of various commissions for organizing international scientific events and as a member of many editorial boards of international database indexed journals. She received awards for her work as a professor and also for the books she published. Professor Rădulescu has published several books and more than 150 articles.

Dr. Stefanie Schulte is the Policy Manager at the NSW Irrigators' Council. The Council has 26 member organizations through which it represents 12,000 water licence holders in New South Wales, Australia. The Council membership comprises of commodity groups, irrigation infrastructure operators, and valley water user associations from across the state. Since starting with the Council in 2011, Schulte has worked extensively on issues surrounding state and national water reform processes in Australia, including the Murray-Darling Basin Plan. She has also researched in areas of water and energy price regulation and environmental management. As part of her work with NSWIC, she closely collaborates with agricultural industry bodies in both California and New Zealand. Schulte holds a Bachelor of Economics (2007), a Master of Applied Economics (2008) and a Master of Economics (2011) from the University of Adelaide. In addition, she also holds a Master of Global Law from the University of Sydney (2017). Prior to her work with the Council, Schulte held various teaching positions at the South Australian universities and at Ngee Ann College in Singapore.

Ms. Fulla Ismail Sharaf is the head of primary care health at the Ministry of Health in Gaza, Palestine, since 2008. She has in addition 8 years' working experience in different projects across Palestine. In 2017, she was awarded an MSc in the field of water and environment from Al-Azhar University. Her academic records include journal and conference papers, book chapters and project reports.



Dr. Mark Speakman is a Tourism academic, Faculty of Tourism, Autonomous University of Guerrero. Speakman studied at the University of Central Lancashire in the UK where he gained a BSc in International Business, followed by a master's in Science in Tourism and a PhD in Tourism. As a result of an initiative by Mexico's National Council of Science and Technology (Conacyt), designed to attract foreign academic talent to Mexican Universities, he joined the postgraduate Sustainable Tourism Management programme at the Autonomous University of Guerrero's Acapulco campus. His initial task, along with teaching and administrative duties, was to conduct a research project that would seek to gain insight into the underlying causes of Acapulco's long-running tourism crisis and to propose potential methods of resolving the situation in a manner that would promote the principles of sustainability. Accordingly, he completed two linked investigations, one which viewed the situation from a complexity theory perspective (available in a peer-reviewed journal), while the other, the chapter in this book, utilized the concept of destination capitals (resources) as its framework. He is the editor of two recently published books on the topic of sustainable tourism, and his current research interests focus upon dark tourism, malevolent tourism, destination evolution, and the tourism history of Acapulco.

Prof. Dr. Michael von Hauff is Professor of Economics at the Technical University of Kaiserslautern. He studied Economics at the Augusta State University/ Georgia, USA, and at the Universities of Stuttgart and Constance. He received his PhD in 1977. In 2003, he was a guest lecturer at the Nanyang Technological University in Singapore and since 2004 he has been a visiting professor at the Institute of Economics/Yangon Myanmar. Moreover, he is a member of several national and international organizations, including the European Academy of Sciences and Arts. In 2009, he was awarded the German Environmental Prize for his scientific achievements in favour of the topic of sustainable development. In a ranking of the FAZ and a research institute, von Hauff was among the 100 most important German economists. This year he has his 30th research anniversary on India. Therefore, he is one of the best known experts on India in Germany. His latest books on India are: v. Hauff, M., Mistri, A.: *Economic Development and Water Sustainability – Study from an Emerging Nation, India*, Manak Publications Pvt Ltd, New Delhi 2016; v. Hauff, M., Veling, A.: *India's Need of a Sustainability Strategy – Creating a Stable and Balanced Development*, Ana Books Delhi 2017.

Dr. Abdullahi Nafiu Zadawais is Lecturer at the Department of Quantity Surveying, School of Environmental Technology, Abubakar Tafawa Balewa University, Bauchi, Nigeria. He obtained a BTech in Quantity Surveying from ATBU Bauchi, Nigeria. He also obtained a master's and a PhD in Project Management from Universiti Sains Malaysia. He is a Nigerian member of the Institute of Quantity Surveyors and a graduate member of the Nigerian Institute of management. His research interest includes procurement management, project management, and also environmental management.

Contributors

Mohammed Ahmed Ali Department of Agricultural Engineering, Faculty of Agricultural Sciences, University of Gezira, Wadmedani, Sudan

Nazliatul Aniza Abdul Aziz School of Economics, Finance and Banking, College of Business, Universiti Utara Malaysia, Sintok, Kedah State, Malaysia

Dumitru-Alexandru Bodislav Bucharest University of Economic Studies, Bucharest, Romania

Florina Bran Bucharest University of Economic Studies, Bucharest, Romania

Jennifer Brown Cotton Australia, Sydney, NSW, Australia

Popescu Cristian Business and Public Administration Faculty, University of Bucharest, Bucharest, Romania

Georgina Davis Queensland Farmers' Federation, Brisbane, QLD, Australia

Australian Rivers Institute, Griffith University, Brisbane, QLD, Australia

Elena Druică Faculty of Business and Administration, University of Bucharest, Bucharest, Romania

Alejandro Díaz Garay Autonomous University of Guerrero, Acapulco, Mexico

Rodica Ianole-Călin Faculty of Business and Administration, University of Bucharest, Bucharest, Romania

Hafiz Waqas Kamran University of Central Punjab UCP, Faisalabad City, Pakistan

Norlida Abdul Manab School of Economics, Finance and Banking, College of Business, Universiti Utara Malaysia, Sintok, Kedah State, Malaysia

Abdelnaser Omran Faculty of Engineering Sciences, Bright Star University, El-brega, Libya

Carmen Valentina Rădulescu Bucharest University of Economic Studies, Bucharest, Romania

Magdalena Rădulescu Department of Finance and Accounting, University of Pitesti, Pitesti, Romania

Stefanie Schulte New South Wales Irrigators Council, Sydney, NSW, Australia

Odile Schwarz-Herion Dres. Schwarz-Herion KG Detective Agency, Ettlingen, Baden-Württemberg, Germany

Fulla Ismail Sharaf Palestinian Health Information Centre, Ministry of Health, Gaza Strip, Palestine

Mark Speakman Autonomous University of Guerrero, Acapulco, Mexico

Michael von Hauff Professor für Wirtschaftspolitik und Internationale Wirtschaftsbeziehungen, Technische Universität Kaiserslautern, Kaiserslautern, Germany

Abdullahi Nafiu Zadawa Quantity Surveying Department, School of Environmental Technology, Abubakar Tafawa Balewa University, Bauchi, Nigeria

Chapter 1
Progress in Economic Thought: Neoclassical Economics Versus Sustainable Economics

Michael von Hauff

Abstract All scientific disciplines are characterized by continuous development under a varying dynamic. This applies to the engineering sciences, the natural sciences, and the humanities, as well as to economics and other scientific disciplines. This is often referred to as scientific progress as observed in the context of the many sub-disciplines of the individual branches of science. A somewhat bold specification of progress in an economic sense allows scientific progress in general to be described as follows: If the younger researchers in a discipline could know and do all that the older generations have known and done plus just a bit more, scientific progress will result. This chapter focuses on the progressive thinking in neoclassical economics and the sustainable economy, which is characterized by controversy.

Keywords Neoclassical economics · Sustainable economics · Scientific disciplines · Varying dynamic · Continuous development · Scientific progress · Controversy

1.1 The Problem

All scientific disciplines are characterized under various dynamics by continuous development. This applies equally to the engineering and natural sciences, the humanities, and social sciences, as well as for other scientific disciplines. In this context, we often speak about the scientific progress achieved in many sub-disciplines of a branch of science. In an analogy to the somewhat bold specification of economic progress proposed by *Sturn*, scientific progress can generally be described as follows: When young scientists of a discipline know everything and can do everything that older generations have known and done, plus some more, then we

M. von Hauff (✉)
Professor für Wirtschaftspolitik und Internationale Wirtschaftsbeziehungen, Technische Universität Kaiserslautern, Kaiserslautern, Germany
e-mail: hauff@wiwi.uni-kl.de

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have scientific progress (Sturn 2011). A differentiation on what can be claimed as progress is presented by *Vogt*:

> The term progress consists of two components: (a) movement – spatial movement in its primary literal sense, also temporal movement in terms of development and change; (b) improvement – an increase in quality; the evaluation criteria is either understood intrinsically as autotelic or as instrumental. These two components correspond with a dimension of quantity and a dimension of quality which are both indispensable in the definition of progress. (Vogt 2016, p. 4)

This differentiation of content-related criteria is very important and quite significant to the purpose of this paper. Specifically, the differentiation of quantity and quality dimensions, according to Vogt, is essential to any practical definition of progress. However, it must also be noted that controversy has crept into various scientific disciplines concerning the “proper orientation or the desired qualities” of progress. This has led to different evaluations or assessments of scientific progress. Controversy of this sort has happened before, for example, in economics. Not only the great controversies of the past like the “Bourgeois economy versus Marxism” but also the controversy between *Monetarism* versus *Keynesianism* emerged in the 1970s. The controversy centered on the issue of what the government can or should contribute to macroeconomic stability. Consequently, there have been different assessments of progress in economics. In scientific disciplines like economics, for example, controversial positions exist, and there is generally no consensus about progress.

Looking at the current discussion within the framework of economics, it is possible to observe various schools of thought that lead to different assessments of *economic progress*. A few examples, by no means exhaustive, are provided here. On one hand, mainstream economics is generally rated as being positive, requiring only marginal “correction” at most. This group of representatives would also rate scientific advances as positive. On the other hand, many economically relevant crises in the past few decades have led others to question whether the study of economics is in crisis or, more dramatically, has proven to be a failure. The discussion was especially aggravated by the *global financial and economic crisis* but is also heightened by the worsening reports on the *climate crisis*. In this context, the book by *Lesch* and *Kamphausen* with the title *Mankind aborts itself: Earth gripped by the Anthropocene* is attracting a great deal of attention. Doubt is cast on the whole concept of economic progress. From a critical perspective, the contribution of modern economic studies in explaining the economic processes and in solving the recent challenges is increasingly called into question (Beckenbach et al. 2016, p. 19). Consequently, both economic students and experienced economists are reflecting on whether there needs to be a change or expansion of the content of the economics curriculum. An increasing number of students in many countries are expressing their discontent with the economics curricula. Some band together in initiatives to demand a reorientation of economics programs. In Germany, for example, the “network for plural economies” calls for more pluralism, especially in economics. The critique is directed mainly at the neoclassical school as the running paradigm in economics. In the context of the demand for more economic plurality, the literature

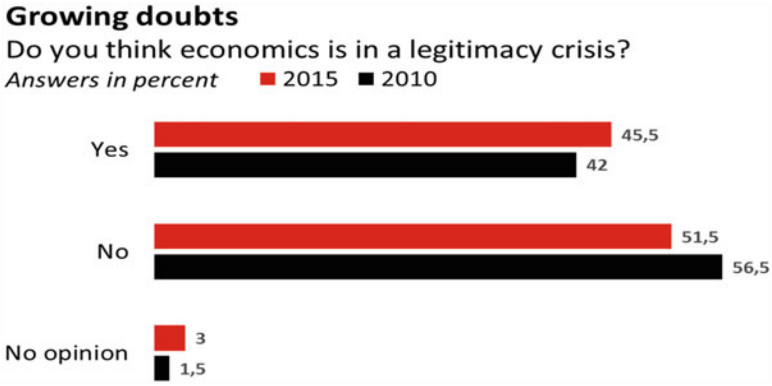

Fig. 1.1 Survey of economists about the legitimacy crisis. (SZ-graphic: Lisa Bucher; Source (5): Third major survey by Neuewirtschaftswunder.de/SZ, May/June 2015)

is beginning to focus on the difference between orthodoxy and heterodoxy (Colander 2004, p. 490; Colander 2015, p. 229). However, it is not just about plurality but also the increasing complexity of the challenges to be met. In 2015, members of the *Verein für Socialpolitik* (German Economic Association) were asked in an opinion survey about the topic "New Thinking." The target group consisted primarily of practicing and research economists with doctor titles from Germany, Austria, and Switzerland. The findings clearly indicate that the growing discomfort with their own discipline is not only evident among business and economics students. While 51.5% of those surveyed denied that economics is facing a crisis of legitimacy, 45.5% think it is. What is noteworthy, as shown in (Fig. 1.1), is that during the period 2010–2015, the percentage of those concerned increased from 42 to 45.5% and the corresponding percentage of deniers dropped from 56.5 to 51.5%.

The results prompt the question of what is the alternative paradigm to the neoclassical paradigm. The following comments are exclusively limited to the sustainable development paradigm adopted for the twenty-first century as the new paradigm by the world community at the *Conference in Rio de Janeiro* in 1992. The paradigm is based on the fact that many of the multifaceted environmental, economic, and also social challenges of the past have, in part, not been sufficiently solved or, perhaps, have even gotten worse. This gave rise to a tridimensional understanding of sustainable development, which is an effort to give equal weight and ranking to the environmental, economic, and social dimension. This paper focuses on the relationship of the sustainable development model to the *neoclassical school* as illustrated by the current controversy over economic growth. The controversy surrounding the idea of progress in the economy, in terms of the approaches to solving important economic challenges, has given rise to the "progress paradox." The two examples chosen for discussion in the next section help to explain the progress paradox in economic terms. Then, the various assessments of growth in the economy are taken as the subject of section 3. Section 4 explores the reasons for the different understandings of progress in the various approaches to growth. The final section presents a summary of the major findings.

1.2 Selected Examples of the Progress Paradox in Economics

It is undisputed that progress has always been made in economics. This much is clear from the separate disciplines within the field of economics. Since *Solow*'s original growth model (1956), *economic growth theory* in subsequent decades has undergone major development. In terms of his theoretical model of growth, further development has concentrated on both a specification and a differentiation within a framework of endogenous growth theory. The resulting justifications have greatly expanded the state of knowledge supporting continuous growth. As mentioned at the start, economic progress is understood as the expansion of previously available insights or knowledge. There has also been a very significant increase in knowledge at the level of empirical research methods, for example, as shown by the continuous development of econometrics. This increase in knowledge or progress can be subsumed in the concept of cumulative disciplinary progress (von Hauff 2014). However, the increase in knowledge or progress has sometimes faced challenges that have not been adequately solved to date. This is the situation described by Sturn as the economic progress paradox (Sturn 2011). The paradox is not easily explained as a failure of politics or business to adequately implement the research findings of the economists. For example, relatively few contributions from neoclassical growth theory address the potential conflict between growth and the environment in-depth, which is a topic discussed in more detail in the next section. Acemoglu, for example, completely neglects the problem of environmental pollution caused by growth in his widely and internationally distributed textbook *Introduction to Modern Economic Growth* (2009). This, despite the broad global consensus today that:

- Growth may often lead to pollution.
- Humanity is not capable of survival in the absence of functioning ecosystems.
- Creating economic wealth also depends on the availability of functioning ecosystems.

It is useful at this point to present some of the reasons for the existence of the progress paradox. Some economists complain that the increased knowledge is offset by a series of hinderances, some of which are traceable to the contrasting views of economics, seen alternatively as either a self-contained or an open discipline. One much discussed example of this concerns the position taken on the human factor in economics. The question of whether the findings and insights of behavioral economists or neurobiologists are considered in the specification of economic behavior models is of great importance, especially, in the context of sustainable development (von Hauff 2014, p. 36).

The explanation lies with the behavioral model of *homo economicus* and critique of the "human factor." This is the behavioral model preferred by *Gary S. Becker* as well as many other well-respected neoclassical economists (Becker 1976, p. 817). The behavioral model of *homo economicus*, in particular, as it is proposed in microeconomic literature is characterized by *absolute rationality* and *utility maximization*. Consequently, homo economicus exclusively pursues self-interests and is aware of what works to his own advantage. The term selfish is often applied when describing homo economicus. However, the modern homo economicus must be differentiated because his behavior is not always and everywhere that of an optimizer (Kirchgässner 2013, p. 32). This is the context which produced the concept of *bounded rationality*, which dates back to *Herbert Simon* in the late 1950s (Simon 1957). It builds on the psychology of human decision-making behavior, and the approach came to be known as "behavioral economics" in later publications (1987). It introduced a somewhat "weakened" variant of homo economicus. In terms of the sustainable development approach, this allowed a totally new concept of humans and the human factor. As *Ferraro* and *Reid* have pointed out:

> Dissatisfaction with the Homo Economicus worldview has led to much critique, notably in the debates related to sustainable development, where there is a growing awareness of the negative implications of its philosophy, especially its ethos of self-interest in the management and utilization of natural resources. (Ferraro and Reid 2013, p.127)

Manstetten and *Faber* emphasize the *sustainable economy* as the core of a human motivational structure, characterized by respect for the interests of all people. This applies in particular to future generations (Manstetten and Faber 1999). The new differentiation of the *human factor* has far-reaching consequences for the environmental, economic, and social dimensions. The dichotomy in thinking about progress is clear. *Stiglitz* chooses a completely different focus for his criticism of the economic findings of the neoclassical economists and also questions the progress of economic research. He also criticizes the insufficient acknowledgment of the available evidence of *market and policy failure* in the field of economics while citing many examples of recent research findings that suggest the widespread assumption of *efficient markets* is not adequately supported by the scientific evidence.

> Markets provide incentives, but market failures are widespread and a continuing discrepancy exists between social and private returns and in some sectors – like healthcare, insurance and financial markets – the problem is greater than in others, and the state concentrates its efforts, understandably, on those sectors. (Stiglitz 2010, p. 309)

Another unsolved challenge is presented by the many interdependencies that exist between the various subsystems in a society. These are as yet not addressed or are still not adequately considered in economics. To improve the depiction of the challenges and the complexities, more interdisciplinary or cross-disciplinary research is required (Vilsmaier and Lang 2014). One reason for this absence of awareness in the context of economic analysis is that it can be advantageous to hide these interdependencies (von Hauff 2014). This corresponds to *Lerner*'s dramatic assessment that economics is the queen of the social sciences (Lerner 1972). Sturn further notes:

> This implies that "unsolved" (or newly formed) problems in policy coordination and conflict must in some way influence the data of the economic model and would contaminate its royal elegance. On the other hand, managing the demarcations as Lerner has suggested, can have major implications for an economy in crisis. The issue is when the queen of the social sciences fails to reflect and address potential problems with "system relevant" assumptions, it may also have a tendency to consider crisis an anathema and no longer truly work on the theoretical horizon. Indications of this are the difficulties in managing (in theory and practice) those problems, crises, and systematic risks that are not seen and understood solely in isolation. Specialization/partialization, as a condition of progress is indissolubly linked to a "machine model of progress", but the present challenges clearly point beyond a machine model – towards combinatorial progress that cannot be understood as the perfection of a machine. (Sturn 2011)

In the context of avoiding or overcoming unresolved challenges, the paradigm of sustainable development and the sustainable economy offer new perspectives. From an economic perspective, sustainable development is concerned with securing the basis of life and production. Under the three-dimensional framework, which as mentioned above advocates for the equal importance of environmental, economic, and social dimensions, there appears a new understanding of equilibrium that is much more comprehensive than in the neoclassical economics. The sustainable development approach aims to maintain the environment globally and permanently while using this as the basis for developing and stabilizing the economic and social systems. In addition to tridimensionality, the second constitutive feature of sustainable development is its *intra- and intergenerational equity*. Based on these two constitutive features, the claim of sustainable development on the economy is discussed in the next section in terms of economic growth, one of the most important sub-disciplines in the field of economics.

1.3 Different Assessments of Economic Growth

The assessment of economic growth is accompanied by intense controversy, which partially explains why no uniform understanding of progress can be given. Yet, this controversy is not new. In opposition to the long-standing positive assessments about economic growth, *Mishan* already stated the negative consequences in his 1967 book *The Costs of Economic Growth*. The controversy has been highly differentiated by proponents and opponents in recent years. In principle, the opposing positions can be condensed: the proponents of growth seeing it as an opportunity for greater prosperity and for the stabilization of market-based systems. Meanwhile, the opponents of growth see a significant risk in the continuing burden on the environment and the increasing institutional income and wealth disparity. Of course, representatives of both sides propose further differentiation. Some of the proponents of economic growth simply do not acknowledge the risk. Some other growth advocates, on the other hand, are aware of the environmental risks and advocate a reduction in their environmental impact (Weder di Mauro 2008). However, taking into account the risks posed by economic growth, they still see great opportunities to improve human well-being.

The growth proponents continue to point out that growth is an essential condition for the positive development of an economy. Many theoretical analyses and empirical studies show that the development of the *labor market*, that is, maintaining both existing jobs and creating new jobs, depends very much on *positive growth rates*. Also, the *social security systems*, especially with current *demographic developments* in many industrialized countries, are substantially strengthened by positive growth of the economy. Furthermore, it can be said that with positive growth rates, *state budgets* grow and the state is able to better meet its increasing duties and expenses. Finally, there is an argument proposed in the literature that with rising growth rates, a *redistribution of growth* is more likely to gain acceptance than with *stagnant growth* rates. In summary, economic growth, in principle, can be seen as a prerequisite for the stability of *market-based systems*.

The opponents of growth are those who reject growth out of principle (Jackson 2017), as will be explained in more detail later. A growing number of *growth opponents*, i.e., those representing *degrowth*, even demand a reduction in growth (Latouche 2007, 2009, 2010). Finally, there is also a group of *growth critics*, who demand an *environmentally and socially balanced growth* in the context of sustainable development (von Hauff and Jörg 2017). The critics of growth clearly reject economic growth, primarily, because of the social risks or the environmental pollution. The starting point for both proponents and opponents of growth is the assessment of overall economic growth. The indicator used for this is *gross domestic product* (*GDP*). However, both positions neglect the fact that in an *integrated economy*, growth only happens in the *ideal state*. In reality, far more industries are growing than those that are stagnating and those that are shrinking. This differentiation is indeed relevant for assessing progress. In the process, it should be noted that the growth of individual sectors and industries is also characterized at times by *dynamic structural change* (von Hauff and Parlow 2014).Looking further at the relationship between growth and the environment, for example, an examination of the growth sectors reveals some with a high environmental impact and some with a relatively low environmental impact. From an economic perspective, at least, the progress in the growth sectors can be seen as positive. Yet, if the growth sectors contribute to a high degree of environmental pollution, the progress must be viewed critically and, perhaps, even rejected as seen from the perspective of sustainable development. Growth sectors such as *health care*, *geriatric care*, but also the growing *renewable energy sector* all have a relatively low *environmental impact* and could be categorized as “progress” from an economic, ecological, and social point of view. A review of the growing *polluting industries* is needed to find ways to transform them into environmentally friendlier sectors.

The advantages and disadvantages of *economic growth* should also be evaluated from the perspective of *demand*, i.e., *consumption*. From the perspective of *consumer sovereignty* as one of the central paradigms of the neoclassical economy, growth of consumption is seen as progress. According to the *consumer sovereignty paradigm*, every person should be able to purchase and consume the consumer goods of their choice (von Hauff 2015). From the perspective of sustainable development, on the other hand, consumption should be held accountable to the requirements of all three dimensions (environment, economy, and society) if it is to be sustainable. This stems from the realization that consumption can result in negative environmental as well as social consequences: Consumption can cause pollution, and *excessive consumption* contributes to human suffering. This is why terms such as *consumerism* were coined for use in literature. The American economist and sociologist *Thorstein Veblen* coined the term *conspicuous consumption* in his 1899 book titled *The Theory of Leisure Class* (2000). *Demonstrative consumption* or *demonstrative waste* is a public display of consumption, which is clearly intended to show what a person can afford. It is not so much about satisfying a need in the narrower sense but rather about making *social status* visible and, if necessary, climbing even higher. In this sense, Jackson, one of the important critics of growth, added a new twist to the paradigm: Consumption must always increase (Jackson 2017).

1.4 Rationales for Progress in the Various Approaches to Growth

The proponents clearly classify rising growth as economic progress and, to the extent growth may bear a relationship to the environment, itis not considered to be a fundamental contradiction to preserving the environment. In sharp contrast, the *growth opponents* see economic growth – at a minimum – as ecological but also as a *social burden*, which should be avoided, and they reject the idea of growth as positive (Fig. 1.2). Each position, that is, proponents and opponents, uses a different line of reasoning that also leads to different assessments of progress. This section is used to describe the five most widely discussed approaches to the growth controversy today and their separate assessments of the relationship between growth and environment.

Neoclassical Growth Theory In discussing the relationship between growth and the environment, the proponents of the *neoclassical growth theory* assume that growth is necessary to solve *environmental problems*. This position advocates that environmental problems can only be solved at a certain economic level, which can

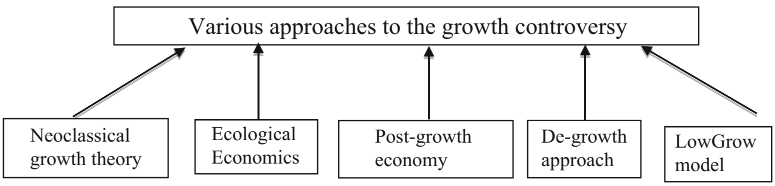

Fig. 1.2 Various approaches to the growth controversy (Source: Own chart)

only be achieved through growth. They apply the principle that *environmental protection measures* are associated with costs. *Industrialized countries*, based on their level of economic development, are better able than many of the *developing countries* today to tackle the solutions to their environmental problems. The quote below sums up the justification of positive economic growth: "In Germany and Europe, [growth] is the only way to ensure *social security* and the *standard of living* over the long term. Its *policy goals* have not only economic importance, but also great moral significance" (Paqué 2010).The growth opponents often overlook the point that in the neoclassical growth theory, *environmental damage* is also partially included in the theoretical models. In the 1970s, against the backdrop of the *first oil crisis* and a report titled "The Limits of Growth" that received widespread attention, the neoclassical growth theory was extended to cover the resource problem: Still, for a *resource economy*, the central question is how to sustain economic growth over the long term when *nonrenewable resources* are essential to achieving growth (von Hauff and Jörg 2017, p.63). In addition, some neoclassical growth models have taken *environmental pollution* into account and shown that it actually leads to a limitation of production possibilities (cf. et al. den Butter and Hofges 1995). Logically, it follows that a stabilization or even an improvement in *environmental quality* is associated with *pollution avoidance costs*, which either lead to a reduction in consumption or a reduction in *production capacity investment*. The consequence is that the *social product* in a state of *growth equilibrium* is lower when the environment is considered than in the comparable case without consideration of the environment. Nevertheless, in principle, it can be asserted that the uncertainties and risks associated with a *scarcity of resources* (also with the environmental impact resulting from the emissions associated with growth) are not sufficiently taken into account in the neoclassical growth theory. The full extent of the challenge is not acknowledged. In the *neoclassical economy*, growth is a prerequisite for *positive economic development* and is viewed as progress.

Ecological Economics *Ecological economics* was initially established and developed as a counter to *neoclassical economics* in the USA in the 1980s and later spread to Europe. There is broad consensus in the context of *ecological economics* that the steady increase in the consumption of natural resources as well as the rising pollution as a result of economic growth is not sustainable or future oriented. The proponents of ecological economics support the classification of an economic system as a subsystem of the ecosystem. This justifies the conclusion that the economy is to be returned to the limits supported by ecology. Further *quantitative growth* is rejected for the following two reasons:

- Some individual *ecosystems* are now at the limits of their sustainability, or these have already been exceeded.
- Quantitative economic growth can hardly raise the standard of living in the already highly developed countries.

In particular, Daly (1999), but also other representatives of ecological economics over the past decades, has called for a *steady-state economy*, one that aims for a *stationary state*. As early as 1776, *Adam Smith*, the founding father of economics, wrote about the stationary state of the economy in his much acclaimed book titled *An Inquiry into the Nature and Causes of the Wealth of Nations*." He proposed the concept that a *stationary state economy* would lead to poverty. His conclusion stated: Only growth can ensure the realization of wealth (Smith 2005).

Daly understands a steady-state economy to be "an economy that does not grow nor shrink physically in the long run" (Daly 2005, p. 125). In contrast to Smith and representatives of *neoclassical theory*, he is convinced that beyond a certain point, quantitative growth not only reaches its limits but is also uneconomical and provides the following case as an example: A company or even a household strives for the optimal level of economic activity. When this level is exceeded by further activities, it may happen that additional costs (*marginal costs*) exceed the additional benefits (*marginal benefits*). Daly refers to this situation as *uneconomical*. In macroeconomic terms, he aggregates the base measures. There is rising consumption of natural resources (*green flow*) in order to produce more material goods (*brown flow*). In other words: "As we expand brown flow, we reduce green flow" (Daly 1999, p. 5). The result is "uneconomic growth." So, in this sense, to the representatives of ecological economics, progress is a *non-expanding economy*.

Post-growth Economics Expanding on the work of the *ecological economists*, there is a worthwhile discussion in the framework of a *post-growth economy*. Representatives of this approach also call for an economy without growth. *Jackson* as a representative of the post-growth economy is one of the most renowned economists of a *zero growth paradigm*. In his acclaimed book titled *Prosperity Without Growth*, he argues that prosperity without growth is not just a *Utopian dream* for the highly developed *Western economies*. Rather, he sees it as a matter of sound financial policy and *ecologic necessity* with implementation apparently quite realistic. In rich nations according to Jackson, *basic needs* are provided for in plenty, and the increase in consumer goods can hardly increase material comforts. The question he asks:

> Can steadily rising income for the already wealthy continue to be the legitimate focus of their hopes and expectations – in a world of finite resources and tight ecological limits – in a world still marked by islands of prosperity amidst an ocean of poverty? Or, is there another path to a sustainable, fairer form of prosperity? (2017, p. 4).

In addition to *green economic stimulus programs* such as those initiated after the financial crisis in South Korea, he also calls for ecologically oriented macroeconomics, which should lead to a "Green New Deal." According to Jackson, the *growth dilemma* is expressed, on one hand, by the need to maintain *economic stability* while, on the other hand, doing this within the limits set by ecology. *Ayres* proposes "another engine of growth that operates on the basis of non-polluting energy sources and, instead of polluting products, it provides material services" (Ayres 2008, p. 292). The proponents of a post-growth economy suggest progress means overcoming the growth dilemma. This is why the following model was developed:

Low Grow Model The *low grow model* is viewed as an alternative to the neoclassical growth models and an advanced form of the *post-growth economy*. The central concern of the representatives of this model is the use of modern methods of *mainstream economics*. A leading representative of the *low grow model* is the Canadian economist *Peter Victor*.

In a respected publication, *Victor* and *Rosenbluth* cite three reasons why governments of economically advanced states should consider alternatives to the existing growth model (2007):

- Scarcity of resources.
- Increasing growth in developed countries leads to decreasing social prosperity.
- Growth is not required to achieve political targets like full employment and the reduction on poverty in the Western industrialized countries.

Victor sets himself apart from many opponents of growth or advocates of shrinking growth by criticizing them for reaching conclusions without considering or using the empirical methods of modern economics. He claims they cannot sufficiently show and justify what happens to an economy without growth or with shrinking growth. Instead, they confine themselves to qualitative statements in order to illustrate or substantiate their own arguments.

The approach preferred by Victor is based on a computerized model of the *Canadian economy*. He analyzes the effects of different growth scenarios on selected *macroeconomic indicators*. His original simulation model includes variables such as consumption, public spending, investment, employment, trade, and production. Based on statistical data for the Canadian economy, he developed three scenarios for the period 2005–2035. His forecasts show how various indicators such as the unemployment rate, poverty rate, per capita gross domestic product, debt ratio, and greenhouse gas emissions evolve in relation to the level of economic growth. The three scenarios are briefly introduced below (Victor 2008):

Scenario 1 (Business as Usual) The assumption in this scenario is that gross domestic product will continue to develop as it has over the past 25 years. Another assumption is that there will be no significant change in economic policy. Assuming annual growth of 2.5%, social problems such as the unemployment rate would remain at about the same level. In contrast, poverty and *public debt* would increase, and *greenhouse gas emissions* would increase by 80%.

Scenario 2 (No and Low Growth) What differentiates the second scenario is the slowdown in and finally comes to a standstill. The assumption here is that there are no compensatory economic policy measures to enact. The *macroeconomic effects* in this scenario would be devastating: Per capita gross domestic product would eventually stagnate after a downturn, and poverty, unemployment, and debt would rise sharply. This would lead to *social unrest* that contributes to *political instability*. Victor refers to this state as the "no grow disaster."

Scenario 3 (Low Growth) Scenario 3 demonstrates that *social prosperity* can be achieved without growth. The scenario requires the per capita *gross domestic* *product* to reflect much slower growth in the early stage, and then stagnation sets in starting in 2028. The assumption is that *government interventions* such as *income redistribution* and other government measures are placed in effect, as well as a reduction in the weekly working hours. The following effects are to be expected: The unemployment and poverty rates will initially grow and then fall well below the starting level by 2035. The debt and greenhouse gas emissions will decrease by 30% compared with 2005 and stagnate at a low level from 2018 onward.

Victor has a preference for scenario 3, which he thinks is realistic with deliberate application of *economic policy measures*. Central to his prediction is the reduction in total and average working hours. In addition to reducing the work week, the target includes a broader distribution of work to a larger number of people. The effect would be an increase in the employment rate. However, this scenario has to take into account that a number of measures cannot be fully implemented because certain interest groups in society would oppose the measures. Victor believes that his model could not only be developed and implemented in Canada but, in principle, also in other industrialized countries.

Critics of the *low grow model* pointed out that the effects of its proposed *economic policy measures*, for example, on the *money market* and the *competitiveness* of a country, have not been considered. Consequently, Jackson and Victor have recently expanded the model (Jackson and Victor 2014, 2015, 2016). It is expected that further development or expansion will lead to a well-founded overview of the *macroeconomic effects* of a reduction or *stagnation of growth*, taking into account the effects of economic policy measures. In the context of the realization of an economy without growth, this research can be classified as progress.

Degrowth Approach This approach goes beyond previous approaches to an "economy without growth" by suggesting growth should be reversed in the developed countries. A pioneer of this approach, which is a recent contribution, is the Parisian economist and philosopher Serge Latouche (2007, 2009, 2010). A growing number of representatives of the *degrowth approach* seek a "great transformation" as an alternative to the mainstream of *growth economy*. In this context, it is necessary to transform the growth-dependent and growth-supporting institutions and measures in society and the economy in such a way that they are "liberated" from economic growth. The goal is to overcome the existential dependence on economic growth in many areas of the economy as well as the society. This requirement is based on the realization that the *natural resources* are finite, the *ecosystems* are vulnerable, and increasing consumption does not make many people happier. The *degrowth approach* is a new paradigm for the developed nations according to its proponents. However, this approach is not just about the environment and growth but also about the social dimension of sustainable development. The societal relationship to growth is considered too. The key fundamental principles for this are:

- Emphasize the quality of life rather than the quantity of consumption.
- Achieve the fulfillment of basic human needs for all.
- Seek social change based on a series of individual and community activities.

- Enable a substantial reduction of dependence on economic activities and gain more leisure time.
- Respect the principles of equality, participatory democracy, basic human rights, and also respect for cultural diversity.

The specific consequences of an *economy with reduced growth*, i.e., an economy in which reduced growth, not additional growth, is the target, have not yet been adequately analyzed. Again, with this approach, the absence of sufficient analysis of the consequences implies that no sufficient progress could be achieved, at least up to the present time.

1.5 Conclusions: The Contribution of Economics to the Looming Challenges

The purpose of this paper was to examine the issue of economic progress. The conclusions are primarily limited to addressing the five approaches reviewed. The analysis is based on the stated objectives of the different growth approaches and a consideration of the upcoming challenges. Generally, economics, like any other scientific discipline, should not be further developed only as an end unto itself, but as a response to national and international challenges, with the aim of providing solutions to important challenges. One of the key challenges in assessing the relationship between growth and the environment is that economic growth depends on functioning ecological systems over the long term. Jackson called this the "growth dilemma." Considering this in terms of today's increased knowledge base, the neoclassical growth models have yet to show progress in relation to the environment. The limits of progress stem from neglect or inadequate consideration of the uncertainties and risks regarding sufficient resource availability, including the needs of future generations and environmental impacts. *Climate change* is an important example of the shortcomings and the insufficient progress in mainstream economics in this area. Some growth-critical approaches still lack a coherent analysis of the consequences for an economy without growth or an economy with reduced growth. A major exception to this is Victor's low grow approach and its expansion by Victor and Jackson. The approach has made considerable progress in analyzing the consequences of a *nongrowth economy*. Further development of this approach should be directed toward sustainable growth or green growth, taking into account all three dimensions, including the social dimension as well as *intra- and intergenerational fairness* (von Hauff and Jörg 2017). The term "social growth" is increasingly important in connection with the social dimension. *Social growth* aims to develop a growth model that is socially balanced and less vulnerable to crisis. Primarily, social growth is geared to the contributions of education, health care, and renewable energies to climate protection. These sectors still have a great calling that can contribute to an increase in the common good of society. In modern sustainability research, the relationship between growth and distribution (or fairness) is also increasingly significant. This is a reflection of the worldwide increase in *income and asset disparity*. This problem concerns *income inequalities* between developed and developing countries as well as income disparities within the individual industrialized and developing countries. Although growing income disparities have been empirically proven many times (cf. et al., Reports of OECD 2008, 2011, 2015), recent economics publications are increasingly citing the consequences of this growing inequality. The publications of Stiglitz and *Piketty* have received special attention in recent years. Stiglitz emphasizes in his book *The Price of Inequality: How Today's Divided Society Endangers our Future* that although the per capita GDP has risen in the USA, for example, the majority of citizens have not participated. In contrast, the income among the already wealthy reflected an above average increase by means of rent seeking and other facilities. Stiglitz suggests that functioning societies with large distributional disparities do not function efficiently over time as their economies become unstable and unsustainable. Such societies can expect to pay a heavy price for the huge and increasing inequality. If the trend continues – if nothing is done to counter it (or something is done to accelerate it) – the price that society has to pay is likely to increase (Stiglitz 2012). Piketty presents a similar argument. He squarely attributes the income and wealth disparity to the rise in capital earnings relative to earned income. As an expected consequence, Piketty cites increasing social tensions for the twenty-first century, which lead to instabilities in capitalist systems.

The Marxist apocalyptic vision could be avoided through the advancement and spread of knowledge, but there has been no change in the deep structures and inequalities of capitalism – at least, not as much as envisioned in the optimistic decades after the Second World War. If the return on capital investment is permanently higher than the growth rate of production and earned income – which was the case in the 19th century and threatens to become the rule again in the 21st century – then capitalism will always automatically generate unacceptable and arbitrary inequalities and radically question the principle of performance on which our democratic economies are based. (Piketty 2014, p. 13)

The evolution of *income distribution* is often based and justified on the idea of performance. The principle is used in *neoclassical economics* to justify *income and wealth disparities*. However, especially in the context of sustainable development, the question arises as to what happens when the solidarity and coherence of a developed society are jeopardized, for example, by *income disparities* and the resulting *social tensions*, as shown by Stiglitz and Piketty. The effect on economic development and stability is negative. The growing criticism regarding the empirical findings on the relationship between growth and distribution is justified. The *sustainability paradigm*, in contrast to *neoclassical economic development*, clearly has greater potential for progress. In conclusion, more intensive scientific studies of this paradigm and the accomplishment of specific implementation measures can further exploit this potential for progress.

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Chapter 2
Mining Environmental Disasters in North and South America: The Current Practices and the Way Forward

Odile Schwarz-Herion and Abdelnaser Omran

Abstract Mining refers to the exploration for and removal of minerals from the earth as essential major sources of energy and materials. Mining often involves major risks for the natural environment and residents by air and water pollution from chemicals and heavy metals. Therefore, the environmental and social responsibility of mining operators includes protection of the air, land, water, and humans by sustainable mining practices and disaster prevention. The risks of mining are especially high in developing nations and takeoff countries with lax safety standards. In recent years, two dramatic mining disasters happened in Latin America. In August 2014, a copper mine owned by *Grupo México*'s subsidiary *Buenavista del Cobre* spilled 10.5 million gallons of copper sulfate acid into Mexico's public waterways. In November 2015, in *Minas Gerais* state, Brazil, the *Fundão* backwater dam burst at an opencast mine which was run by *Samarco* and another dam ruptured, sending a wave of chemically hazardous sludge throughout the nearby regions, killing 20 persons, causing enormous social, environmental, and economic damage. Taking these disasters as case studies, this chapter will review the failures of the mining industry in Latin America which led to these disasters while offering some suggestions on how to avert such disasters in the future.

Keywords Mining disasters · Environmental and social responsibility · Buenavista del Cobre · Grupo México · Fundão backwater dam · Samarco · Disaster prevention · Sustainable mining practices

2.1 Introduction

> It seems that almost every time a valuable natural resource is discovered in the world – whether it be diamonds, rubber, gold, oil, whatever – often what results is a tragedy for the

O. Schwarz-Herion (✉)
Dres. Schwarz-Herion KG Detective Agency, Ettlingen, Baden-Württemberg, Germany
e-mail: EOKK.Black@t-online.de

A. Omran
Faculty of Engineering Sciences, Bright Star University, El-brega, Libya

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country in which they are found. Making matters worse, the resulting riches from these resources rarely benefit the people of the country from which they come. (Brookner 2013)

This quote by *Edward Zwick*, director of the award-winning movie *Blood Diamonds* (Brookner 2013; Wikipedia 2018a), shows that valuable natural resources won from mining, i.e., "…the extraction of ore, defined as rock from the earth's crust containing valuable minerals…" (The Canadian Encyclopedia 2018) can cause serious problems. Although this movie is set in *Sierra Leone*, West Africa, where the *De Beers* mining company – once founded by the British racist *Cecil Rhodes*[1] with whom *Adolf Hitler* would identify later on[2] (Waterman 1996; Goldschein 2011; Parkinson 2015; Wikipedia 2018a) – is trying to whitewash the dirty image of the diamond industry by a certification app tracing the origin of diamonds (Stoddard 2018; Allen 2012), mining problems are restricted neither to Africa nor to blood diamonds.

Although mining is necessary to win essential major sources of energy and materials, it involves serious risks concerning all pillars of sustainable development, i.e., the ecological, the social, and the economic pillars, often causing significant damage to the natives of the affected countries who once owned the land. Apparently, the indigenous people of countries affected by mining activities recognized these risks already back in 2002, putting severe restrictions on mining in the *Indigenous People's Plan of Implementation on Sustainable Development* (Tebtebba 2002; Schwarz-Herion 2007, with further references).

Latin America has quite a record of problems around mining. This includes not only the violation of federal and state laws by some mining companies, e.g., *Minera San Xavier* (MSX) in *Cerro de San Pedro*, *Mexico,* which is infamous for endangering historic heritage, cultural and environmental goods, as well as human health by cheap technology (Guadalajara 2010; Vargas-Hernandez 2007), but also several disastrous accidents (Hernandez 2010).

Severe mining disasters in Latin America include (1) the August 2014 disaster in Mexico, where *Grupo México*'s subsidiary *Buenavista del Cobre* Mining Company polluted Mexico's public waterways, and (2) the mining disaster in *Minas Gerais*, Brazil, from November 5, 2015, where two ruptured dams caused a dramatic chemical contamination in the nearby regions (Wilton 2015). These two disasters will serve as case studies to highlight certain risks of mining and to figure out some preventive measures to avert such disasters in the future.

Before taking a further look at the two mining disasters mentioned above, it may be interesting to provide a short overview over the history of mining in Mexico and

[1] *Cecil Rhodes* and *Alfred Milner* established a Jesuit-style secret society (Brown 2016) called *The Round Table* – associated with appeasement initiatives involving the Duke of Windsor, Mrs. Simpson, and Hitler – from which the *Royal Institute of International Affairs (RIIA)*, a British foreign intelligence arm, better known as the *Chatham House*, and its various branches including the *Council on Foreign Relations* would emerge later on (Murava 2016).

[2] This is not too surprising as Adolf Hitler who was indoctrinated at the *British Military Psych-Ops War School* at *Tavistock*, Devon, England, in 1912 has been controlled by British intelligence ever since as revealed by intelligence insiders (Smith 2018; Hallett 2006).

Brazil. This will help the reader to gain some insight into the significance of this industrial sector in these two countries.

2.2 History of Mining in Mexico and Brazil

2.2.1 Mexico

Mexico's history of commercial mining started over five centuries ago (FM 2018). Before the Spaniards came to Mexico in 1521, pre-Columbian populations had already been interested in gold, silver, and other metals. The introduction of European production techniques into the "New World" facilitated colonial mining, so that flows of gold and silver from Mexican mines were transferred to the Spanish state coffers. In the subsequent three centuries of Spanish domination, many other minerals including copper, coal, lead, and iron (FM 2018) have been won. Since 1697, the Jesuits established various missions in *Baja California*, reigning the region as an independent Jesuit political entity (Bitto 2016). The Jesuits operated productive mines in Mexico (Bitto 2016) under violation of Spanish law (Rancho Cacachilas 2018; Haydock 2011), enslaving the local natives to mine the gold (Zucke 2017). In the 1700s, the Jesuits benefitted from a trade with pirates, exchanging basic foodstuff against pirate booty including gold. Before the Jesuits got kicked out of Mexico by *King Charles III's Order of Expulsion*, they managed to seal the small canyon and to destroy all documents reminding their misdeeds (Bitto 2016).

Until the 1870s, silver formed over 70% of Mexico's total exports. Back then, mining was mainly built on slave labor – a dangerous and precarious work under inhuman conditions including, among others, deep narrow shafts, longer narrow tunnels, underground flooding, and insufficient ventilation systems (FM 2018). In the period from 1867 to 1876, President *Benito Juárez* tried to draw international capital in favor of Mexico's economic modernization by upgrading the transportation and communications infrastructure. Toward the end of the nineteenth century, Mexico's mining industry expanded in the era of *General Diaz* (FM 2018).

In the 1880s and 1890s, the Mexican mining code was reformed by including liberal codes granting mineral rights (subsoil ownership) to landowners, removing the previous domination of Spaniards and other European mining owners. Due to subsoil ownership, mining concessions of several mines led to the creation of the *Compañía Minera de Peñoles* in 1887 (FM 2018). Although the nationalization of subsoil rights made investors jittery, triggering an economic crisis at the beginning of the twentieth century, the period from 1890 to 1960 has seen several acquisitions, mergers, and fusions with other mining companies (FM 2018). Mexico's revolution in 1910 prepared the ground for the revised constitution enacted in 1917, enabling Mexico to recapture ownership of its mineral resources. Later on, in the 1930s, the state confined the number of mining licenses, fostered the establishment of cooperative societies, and instituted the *Comision de Fomento Minero* ("Commission of Mining Promotion"), paving the way for the establishment of *Grupo México* and

Industrias Peñoles after industrialists like *Jorge Larrea* and *Raul Bailleres* had bought the majority of the shares from *Great Britain*, *Germany*, and the *United States* (FM 2018). The *Constitution on the Exploration and Treatment of Mineral Resources* in 1961 led to the *nationalization of the mining industry* by requiring a minimum of 51% Mexican ownership of mining projects, to persuade foreign investors to sell their mining shares or to establish themselves as Mexican companies (FM 2018). Nowadays, Mexico is one of the largest producers of different minerals.

2.2.2 Brazil

Brazil has quite a legacy of slavery in the mines after gold had been discovered toward the end of the seventeenth century. Subsequently, a major part of the populace of *São Paulo* and *Rio de Janeiro* ensued the gold rush with thousands arriving from Portugal. By 1720, hundreds of thousands of Portuguese as well as hundreds of thousands of indigenous and African slaves had arrived in the region (Sandy 2015). Although slavery was finally abolished in Brazil in 1888, Minas Gerais benefits economically from the exploitation of slaves until today. Moreover, the exploitation of workers in a kind of modern slavery continues nowadays (Sandy 2015). While agriculture is the largest source of employment, mining is the largest source of wealth in Minas Gerais. Gold had been discovered in 1698, followed by diamonds in 1729 (Encyclopedia Britannica 2018).

Once inhabited by the Indian natives, the state of *Minas Gerais*, i.e., “General Mines” in English (Mindat.org. 2018), was famous for its wealth in terms of gold, gems, and diamonds. Sharing borders, inter alia, with *São Paulo*, *Rio de Janeiro,* and the *Federal District of Brazil*, Minas Gerais has 20 million inhabitants and is home to many mines yielding gold and semiprecious gems (Meyer 2010). In the 1700s, the mines were mainly explored by the Portuguese, demanding high taxes on everything which was extracted, repeatedly triggering acts of rebellion from the part of the colonists who tried to fight the Portuguese crown (Meyer 2010).

Although the richest gold sources had been used up by 1800, Minas Gerais is nowadays famous for its semiprecious gems like aquamarine and topaz (Encyclopedia Britannica 2018). Of even greater importance nowadays are the huge deposits of high-grade iron ore and manganese (Encyclopedia Britannica 2018). Today, Brazil exports ca. 75% of its iron ore; the major part of the exported ore is produced in Minas Gerais which also supplies, inter alia, bauxite, iron pyrite, graphite, nickel, and titanium (Encyclopedia Britannica 2018).

2.3 Case Studies

2.3.1 Mexico: The August 2014 Buenavista del Cobre Disaster

2.3.1.1 Company Profile

Buenavista del Cobre S.A de C.V, currently owned by *German Larrea Mota-Velasco*, Mexico's second richest man (Estevez 2017), is one of Mexico's most famous mining companies. It has been operating since 1926 and became a *subsidiary of Grupo México in 1990* (BNAmericas 2018a). Buenavista del Cobre is not only the largest mercury mine in the nation owned by one man but also one of the California mines jointly producing 9/10ths of the mercury mined in the *United States* (Middlecamp 2018). Based in the northwest of Mexico in *Cananea*, *Sonora*, the Buenavista mine – yielding ca. 36 million tons of ore grading 3.3% zinc, 0.69% copper, and over 33 million oz. of silver – is sited 35 km south of the US border close to *Nogales*, *Arizona* (Wikipedia 2018b).

Grupo México and the Buenavista del Cobre mine have become noticeable with various acts of environmental pollution, resulting in nine complaints against the mine since 2008 (Trevizo and López 2014). In 2009, Grupo México had to pay $1.79 billion to the US government to settle hazardous waste pollution at over 80 sites contaminated by its *Asarco* mining operations in 19 states (Trevizo and López 2014).

2.3.1.2 The Disaster and Its Environmental and Social Consequences

On August 6, 2014, *Buenavista del Cobre* spilled 10 million gallons, i.e., 40,000 m^3, of *copper sulfate acid* and high levels of *arsenic* into public waterways near *Cananea*, damaging the *Sonora* and *Bacanuchi rivers* (Wilton 2015; Guevara 2014; Estevez 2017) and inverting the lives of 25,000 people in seven counties along the river (Trevizo and López 2014). *Juan José Guerra Abud,* Mexico's *Secretary of Environment and Natural Resources*, called this ecological disaster "the worst environmental disaster by the mining industry in modern times" (Wilton 2014), posing an immense threat to human health by highly dangerous toxins, leading to a dramatic loss of public drinking waters (Lindsaynewlandbowker 2014). According to *Alberto Rojas Rueda*, head of *Greenpeace Mexico*, the chemicals could enter the food chain, poisoning humans and animals; the decontamination of the area might take 15–20 years (Wilton 2014). *PROFEPA*, *Mexico's Federal Department of Environmental Protection*, stated in an official report: "The spill of the copper sulphate solution could put the integrity of the ecosystem at risk...When a spill of dangerous substances remains unattended, it can cause persistent and increasing damage to the soil, subsoil, water and other natural resources" (Wilton 2014).

At least 360 people experienced health issues from the incident. Schools had to close and 322 wells had to shut down (Estevez 2017). Farmers in the affected communities cannot sell their goods because of buyers' fears of contamination. The disaster affected ca. 24,000 people directly and 250,000 people indirectly in seven communities on the shores of the *Sonora River*, 25 miles southward of the Arizona frontier (Guevara 2014; Wilton 2014). According to PROFEPA, the environmental damage from the accident may exceed $134 M (Wilton 2014).

2.3.1.3 Causes of the Disaster

While *Grupo México* was unavailable for comment when approached by the *Daily Star* about the accident, an interview with *Arturo Rodríguez Abitia*, the deputy director for industrial inspection at *PROFEPA* revealed the following (Trevizo and López 2014):

- Grupo México was using unfinished installations without the necessary operating permits under violation of several federal laws.
- The failure of a seal on a polyethylene pipe in one of the leachate ponds at the Buenavista del Cobre mine caused the spill.
- Grupo México had failed to install a valve which could have stopped the spill.
- There were not any overflow ponds or impermeable linings confining this sort of spill as the project was still under construction.
- The company informed the authorities with a delay of 28 h under violation of the law which requires an immediate notification.

So, apparently human error, negligence, and violation of laws were responsible for the incident (Trevizo and López 2014).

2.3.1.4 Economic and Legal Consequences

The new installations at the mine have been closed until the mine will have overflow ponds and geomembranes. Any further activities have been suspended as ordered by PROFEPA (Trevizo and López 2014). The company did a cleanup along the banks of the nearly 270 km *Bacanuchi and Sonora rivers*, cleaning up the products resulting from the neutralization efforts with lime (Trevizo and López 2014). Grupo México has been obliged to present a remediation plan subject to approval by Mexico's *Department of the Environment and Natural Resources* by the end of October 2014 (Trevizo and López 2014).

After Mexico's federal environmental authorities had found 55 irregularities in Buenavista del Cobre's activities, Grupo México received a fine of 23 M pesos (ca. $1.8 M) and pledged itself to donate to a trust fund of 2 billion pesos (ca. $154 M) for remedy, repair, and indemnification for health effects in the communities afflicted by the spillage as well as for environmental and economic damages (Estevez 2017). Although the trust is judicial by nature, it consists of a technical committee with a representative from the government, one representative from the company, and three technical experts from academic institutions. The trust cannot disappear unless the committee decides (Trevizo and López 2014). Furthermore, Grupo México *obliged itself* to take various measures, including the establishment of 28 water purification facilities for the filtration of heavy metals and the construction of a clinic to treat those who suffered health problems (Estevez 2017).

In 2015 and 2016, 12 different complaints against government agencies were filed under the 2013 law on the constitutional complaint mechanism (*amparo*) by the municipalities concerned by the incident – not only for the various damages caused by the spill but also for the denial of access to information about the incident (Business and Human Rights Support Center 2018). The legal entitlements referred to violations of healthy environment, access to water, property, communities' right to work, as well as compensation for damages and participation in public affairs (Trevizo and López 2014; Business and Human Rights Support Center 2018). The lawsuits also concerned government failure to comply with environmental and safety regulations and to realize remediation plans (Business and Human Rights Support Center 2018). In order to help determine the cause of the spillage, the communities had filed a petition under the *Foreign Legal Assistance Status* to the *US District Court* in *Arizona* in April 2016, demanding information about the mine's operations and environmental practices from Buenavista del Cobre's parent company, the *US-headquartered Southern Copper* (Trevizo and López 2014).

Finally, in August 2016, Southern Copper provided the requested information by court order. Two months later, several *UN Special Rapporteurs* pushed the Mexican government to provide information about the actual implication of the spill and the measures adopted to alleviate its consequences (Business and Human Rights Support Center 2018; Trevizo and López 2014). Half a year later, a *UN Working Group on business and human rights* stated in its *country visit report* that the government *and* Grupo México missed to perform their duties under the initial *trust fund agreement* and that the *Attorney General* failed to open a criminal investigation (Business and Human Rights Support Center 2018). In August 2017, the *First Tribunal* of the *Sonora State district* supported the plaintiffs in a lawsuit concerning the government's omission to take care of health problems caused by water pollution, whereas the *Supreme Court of Justice* dismissed a case with Buenavista del Cobre as defendant for their failure to comply with environmental norms since the company could generally not qualify as a responsible authority under the 2013 *amparo* law (Business and Human Rights Support Center 2018). In August 2017, the trust fund had been closed, a decision vindicated by the government who claims that the restoration and reimbursement plans had been fulfilled – an allegation strongly disputed by the inflicted communities (Business and Human Rights Support Center 2018; Trevizo and López 2014).

The court still has a decision to make if *Fideicomiso Río Sonora* as *an entity composed of both public and private actors* can be sued in court for human rights violations under the 2013 *amparo law*. On August 22, 2018, the *Mexican Supreme Court* heard a constitutional complaint (*amparo*) from members of the rural community of *Bacanuchi* challenging the construction of a new backwater dam in the catchment area of the Sonora River by Buenavista del Cobre in which the applicants requested the Court to acknowledge their right to be consulted on environmental affairs of public interest (Business and Human Rights Support Center 2018).

2.3.2 Brazil: The Samarco Dam Disaster and Its Environmental and Social Consequences

2.3.2.1 Company Profile

Samarco Mineração S.A. is "…a Brazilian entity jointly controlled by *Vale* and *BHP Billiton Brazil Ltda*, in which each shareholder has a 50 % ownership interest" (Mining Data Solutions 2018). Located in *Belo Horizonte* in Minas Gerais state, Samarco Mineração was established in 1977 (BNAmericas 2018b). Being active in the extraction, granulation, and export of iron ore, it has four granulate plants in *Anquieta municipality*, in Brazil's *Espírito Santo* state, and three concentrators in its *Germano plant* in Minas Gerais state (BNAmericas 2018b). Samarco Mineração conducts business worldwide (Bloomberg 2018).

Before the Samarco dam disaster to be discussed in the following sections, Samarco had already been fined six times between 2005 and 2010 for breaking environmental laws, inter alia, by rejecting inspections, by operating without proper licenses, furthermore by breaking pollution laws, by establishing new projects without a proper license, and by dumping pollutants in a creek (Pitman 2015). Furthermore, BHP Billiton as one of Samarco's two 50% owners has already been responsible for many company-related fatalities, e.g., 37 fatalities from coal mine explosions and significant environmental harm, among others, by its Olympic Dam, by the largest uranium mine on the globe, by copper waste spills in Chile, as well as by the release of millions of tons of copper waste in the *Ok Tedi* and *Fly River basins* in *Papua New Guinea*, destructing the environment and affecting 50,000 people (Viana 2018). Samarco's other 50% owner *Vale* made a name for itself when a joint raid by the *Ministry of Labor* and *Federal Police officers* carried out in February 2015 found that 309 drivers employed by a subcontractor driving trucks between two Vale excavations were being kept in slave-like conditions (Sandy 2015).

2.3.2.2 The Disaster and Its Consequences

> The dam break led to the destruction of all forms of life in the region. Mud covered everything, resulting in 20 deaths and unmeasurable environmental destruction. We have seen whole communities destroyed by BHP Billiton and Vale's operations. They have lost everything, without receiving any real compensation…what is becoming evident is the blatant corporate capture of our government by transnational companies. (London Mining Network 2016)

Thus *Rodrigo de Castro Amédée Péret* from the *Churches and Mining Network in Latin America* described the disaster in the state of Minas Gerais in Brazil on November 5, 2015, when ca. 40–62 m^3 of water and sediment from iron ore mining flowed on a mountain slope after the *Fundão dam* had burst at an open-pit mine operated by *Samarco* and another dam had ruptured (The Guardian 2015). Due to this incident, the "biggest disaster of its kind" (Kiernan 2016), a wave of chemically highly toxic mud was released into neighboring regions (Winston 2016), triggering a stream of mud washing away villages and farmland; killing 20 people, fish, and aquatic life hundreds of km away; making potable water non-drinkable for hundreds of thousands of persons; displacing 700 people; destroying livelihood; poisoning hundreds of kilometers of the *Rio Doce River Valley*; and travelling over 400 miles through the *Rio Doce Basin* in Southeast Brazil before reaching the *Atlantic Ocean* (Kiernan 2016; Phillips 2015; Richard 2016; The Guardian 2015).

The severe environmental effects impact the livelihoods of *over one million people* in 41 communities, constraining local access to clean water, fishery resources, plant production, hydropower, and raw materials (Wilson et al. 2016). Threats to human communities living at the riverside are especially acute for disadvantaged populations from isolated areas who depend from fisheries and subsistence agriculture (Wilson et al. 2016).

Ecologists foresee various negative impacts like chronic vegetative loss, changes in biological diversity of fish populations, bad recovery in polluted areas, impairment of ground stability and drainage monitoring, and enhanced risk of other geomorphological disorders, including mudslides, bank collapse, mass displacements, bank failure, and mass motions (Wilson et al. 2016). According to expert estimates, the regeneration period of the biophysical composition, the eco-function, and the biological diversity in impacted areas might take decades or even a century (Wilson et al. 2016). The devastation of watersides, fresh water, and maritime ecological systems eradicated essential biological resources and eco-processes preserving traditional livelihoods and disturbing the provisioning of fresh water, fisheries, agriculture, and tourism (Wilson et al. 2016).

2.3.2.3 Causes of the Disaster

As the police found out, the *main cause* of the dam burst had been the *enormous accumulation of water* inside the reservoir (Gonzalez 2016). Dewatering errors and indicators of erosion had already been appearing since the tailings dam was opened in 2008 (Gonzalez 2016). *Otávio Guerra*, a civilian police expert, revealed that a reduction of the water flow caused more fluid to remain within the dam, thus resulting in reduced reliability and stability of the embankment structure, finally leading to the dam break (Gonzalez 2016).

Samarco's *board of directors* consisting of representatives of Vale and BHP Billiton had been repeatedly informed about the dam's construction problems and measures to remedy the problem in various meetings between 2009 and 2014 as proven by the minutes appearing in the judicial files. *Joaquim Pimenta de Ávila*, a consultant who inspected the area in December 2014, had already warned Samarco against "static liquefaction" (Phillips 2018), telling them that the situation may get out of control (Phillips 2018). Internal documents cautioning that a maximal potential loss due to a liquefaction pause could result in up to 20 deaths, have serious impacts on land, water resources, and biodiversity over 20 years; and cost over 3 billion dollars (Phillips 2018) show that the company was fully aware of the risks. Nonetheless, the devices supposed to measure liquid pressure were not properly waited and the company did not have any warning siren (Phillips 2018). *José Adércio Sampaio*, supervisor of a taskforce of federal prosecutors, stated in his summary of the criminal case: "They prioritized profits and left safety in second place" (Phillips 2018). So, after all not only human failure but also human greed facilitated the disaster.

2.3.2.4 Economic and Legal Consequences of the Disaster

Right after the accident, Samarco's mining operations were stalled and have not been taken up until today. Furthermore, Samarco had 30 M reals (£5.2 M) of its capital frozen by a judge in Mariana to remedy damage done in the region (The Guardian 2015). It initially agreed one billion real (£174M) of compensation and prevention measures with state attorneys, but according to estimations by *Carlos Pinto* – heading a team of environmental prosecutors for the State of Minas Gerais who investigated the tragedy – the charges will be much heavier.

In October 2016, Brazilian Federal Prosecutors filed charges against 21 people for "qualified homicide with eventual intent[3]" (Gonzalez 2016; Kiernan 2016; Nogueira and Blount 2016) in connection with the disaster. Charges were filed, inter alia, against former and current top executives of Vale S.A. and BHP Billiton Ltd. including the former Samarco Chief Executive *Ricardo Vescovi*, Vale's Iron-Ore Director *Peter Poppinga*, eight Vale and BHP representatives at Samarco, and an engineer from *VogBR* for his report assuring the dam's safety (Kiernan 2016; Gonzalez 2016). According to the prosecutors, the accused, who include 16 Brazilians, two Americans, a Briton, a French citizen, a South African, and an Australian, may face sentences of up to 54 years. *Eduardo Santos de Oliveira*, one of the prosecutors, said about those who died in the disaster: "These people were murdered" (Nogueira and Blount 2016).

Additionally, a separate civil lawsuit by public prosecutors for damages in the amount of USD 48 billion was initiated in 2016. In January 2017, the public prosecutors and the three companies (Samarco, Vale, and BHP Billiton) signed a $680 M preliminary contract for restoration work (Phillips 2018).

Beyond that, 3000 investors have signed up to participate in a class action against miner BHP over the Samarco dam disaster of 2015 for continuously violating

[3] Also known as "dolus eventualis," i.e., committing murder without direct intent to kill but knowingly and deliberately accepting the risk of death

disclosure obligations and engaging in misleading and deceptive conduct. According to the statement of claim, filed in the *Federal Court of Australia*, problems at the Fundão tailings dam in Brazil were encountered since 2009, and BHP who was aware of the "dam failure risk" at least since August 27, 2014, should immediately have informed the *Australian Securities Exchange* of this risk and the "consequential financial risk" (Gray 2018). Nevertheless, none of these negative consequences of the November 2015 Samarco dam disaster have finally compelled Samarco's 50% owner Vale to improve its poor safety precautions: On January 25, 2019, the *Brumadinho dam*, equally located in Minas Gerais, Brazil, broke, triggering an unprecedented ecological disaster that killed nearly 300 people (The Guardian 2019).

2.4 Conclusion and Proposed Solutions

The two case studies in Mexico and Brazil showed that in both cases, human failure and in the second case additionally human greed caused the disaster and that prevention is better than cure in mining operations. In the *Buenavista del Cobre disaster* case, it has been irresponsible of the company to use unfinished installations. Regarding the Samarco dam disaster, it was unforgivable that Samarco – after having repeatedly been briefed on the risks and possible disastrous consequences including the concise maximum number of potential fatalities along with measures to mitigate the risks – failed to install a warning siren along with a functioning emergency system which would have been obligatory under the given circumstances, even if the lawmaker in Brazil obviously failed to oblige mining companies to have alarm and warning systems (Phillips 2018).

At first glance, the reputational loss due to this dramatic incident, unpleasant legal procedures, as well as the liabilities created by these disasters may be sufficient to serve as a deterrent example to other companies. Nevertheless, the fact that these disasters happened although these companies had already been repeatedly fined for legal violations of environmental laws and human rights shows that the state has to take more decisive action to ensure appropriate measures for safety and environmental protection in the mining sector. Therefore, the legislative, the executive, and the judicial powers in both countries should be more rigorous in their actions toward those mining operators who repeatedly violate legal regulations to achieve a deterrent effect in the long term. Currently, however, some state actors in Mexico and Brazil do not seem to act in a responsible manner.

In the Buenavista del Cobre disaster case, the government's failure to comply with environmental laws and safety regulations as well as the Attorney General's default to open a criminal investigation shows apparent weaknesses in parts of the executive power in Mexico. It is also highly problematic that the Mexican government defends the closure of the trust fund by claiming that the restoration and reimbursement plans had been entirely fulfilled, while the affected communities strongly deny the veracity of this claim in a credible way (see Sect. 2.3.1.4, paragraph 4).

The establishment of a properly working alarm system along with appropriate emergency measures laid down in a corporate manual along with yearly obligatory random governmental inspections should be a *basic legal requirement* for any mining company to receive and keep a license. For that, the legislators in Mexico, Brazil, and many other countries would have to take responsibility. Nevertheless, legal rules alone will not be sufficient. Compliance with environmental and security legislation must also be monitored and enforced by the executive power, if necessary. This requires the permanent employment of excellent and reliable engineers by the state as well as consequent sanctions in case of non-compliance. According to PROFEPA, 65% of the mines operating in Mexico breach the environmental regulations, but only ca. 10% of them are closed (Mendoza 2016).

Finally, all state powers, the legislative, the executive, and the judicial powers, must act responsibly and honestly to avoid such disasters in the future. In the case of the Buenavista del Cobre Disaster in Mexico, the license of the company should have been revoked after the many complaints the company received and after the company had been fined by a foreign government. This goes even to a greater extent for Samarco and its owners. Eventually, a law regulating that a company should lose its license after repeatedly having been penalized for environmental violations, safety regulations, and/or human right violations might help to clean the mining business from irresponsible mining operators. While several parts of the executive power in Mexico have basically failed, the police and public prosecutors in Brazil have done an excellent job and showed a very high level of commitment. Now, it will be up to the judicial power to grant justice.

Ideally, all actors, mining operators, and state actors have to fulfill their obligations to ensure that mining operations are done in a safe and sustainable way. Additionally, global entities like the UN as well as scientists, scholars, and journalists should help to enlighten mining operators and the general public for potential safety and environmental risks of mining to ensure sustainable mining operations, above all responsible disaster prevention measures while doing due diligence on mining companies to expose black sheep among mining operators.

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Chapter 3
Rural Development in Africa: Challenges and Opportunities

Abdullahi Nafiu Zadawa and Abdelnaser Omran

Abstract Rural development comprises development programmes and initiatives intended for enhancing living standard of the rural dwellers. The initiatives are usually taken by local authorities, local and international donor agencies, and related non-governmental organisations. In Africa, this is perhaps because statistical evidence shows that over 80% of the population of most African nations reside in the rural areas. This is a conceptual study aimed at assessing the challenges and opportunities of rural development in Africa based on related literature. Rural development theories were reviewed which include integrated rural development model, sectoral development model, urban development model, and industrial development model. Agriculture has been the most prominent occupation among major rural dwellers in Africa, yet rural development is accepted as much broader than agricultural development, because some other activities associated with rural development provide a substitute to agriculture and serve alternative sources of income and means of survival to the rural poor. As a whole, agricultural development could still serve as a main contributor of rural growth up to the present time, and it continues to serve a significant role in poverty reduction.

Keywords Rural development · Africa · Challenges · Opportunities

3.1 Introduction

The mission of realising the desired rural development in Africa has remained a critical issue. This is perhaps because statistical evidence shows that over 80% of the population of most African nations reside in the rural areas (Nwagboso and Duke 2012). In most African countries, rural communities constitute the greater

A. N. Zadawa (✉)
Quantity Surveying Department, School of Environmental Technology, Abubakar Tafawa Balewa University, Bauchi, Nigeria
e-mail: nafiuzadawa@gmail.com

A. Omran
Faculty of Engineering Sciences, Bright Star University, El-brega, Libya

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percentage of the population whose developmental needs are not satisfactorily fulfilled which continuously denies them the chance to prolifically participate in the development process and enjoy the benefits thereof. African rural communities have not been benefiting with any significance which is linked with the policy implementation gap artificially created by the African governments and leaders. The rural areas have been continuously and consciously exploited and underprivileged to the benefit of the urban areas. According to Aziz (1998), rural development programmes and policies in most African countries, such as Nigeria, Zambia, Tanzania, Sudan, the Benin Republic, the Niger Republic, etc., are mostly intended to aggravate the poverty and sufferings of the rural populace. Nwagboso (2012) further added that rural development in Africa has remained as a propaganda mechanism amongst the elites and patricians. As a result, the nature of most rural development projects in Africa has unrelentingly been influenced by politics. Subsequently, this neglect has resulted in rural communities lacking access to basic infrastructure and social amenity needs, especially water, food, education, health care, sanitation, information, and security, as well as the people having a low literacy level. In the long run, this has led to a low life expectancy and high infant mortality. The majority of the rural dwellers consider these conditions as harsh forcing massive migration into urban areas in search of employment opportunities and better life condition for survival.

3.2 The Concept of Rural Development

Scholars have different understanding of the concept of rural development from the diverse logical perceptions and philosophical background. Yet, the majority of the scholars have conceived of the concept of rural development as not only the process of boosting the per capita income but also as the means of enhancing the standard of living of the rural areas, generally, such as by providing access for sufficient water, food, education, health care, sanitation, information, and security. According to the World Bank (1975), the concept of rural development involves the process of transforming and monetising the rural community from the inherent traditional segregation to integration with the national economy. From another similar viewpoint, Ollawa (2011) described rural development as the process of economic transformation to meet the immediate needs and aspirations of the rural communities and to support individual and collective incentives to enable them to participate in the process of development. This economic transformational strategy could embrace different activities, including upgrading the agriculture sector, the advancement of rural industrial activities, the establishment of the essential infrastructure and social overheads, as well as the formation of applicable decentralised structures in order to allow for mass production (Wilkin 2010). Other scholars, such as Obinozie (1999), defined rural development as a series of schemes aimed at enhancing the life of the rural people in the society. This involves innovative agricultural programmes, employment opportunities, access roads and ease of transportation, health-care facilities and services, better and more affordable housing, supply of portable water, and fair distribution of income amongst the rural societies. Although there are different definitions of the rural development presented by different scholars, it is imperative to know the scope and frontiers of rural development as a field of inquiry. Analytically, rural development is directed primarily and wholly towards the total transformation of the rural communities. Thus, the main essence is to transform the rural societies to contemporary communities, and the prime goal is to alleviate poverty and further lessen the continuous migration of people from rural to urban centres who penetrate every nook and cranny of urban cities in search of a better means of livelihood.

3.3 Global Scenario of Rural Development Programmes

There have been rural development programme initiatives since the 1950s, but, conceptually, the programmes were brought to the forefront of development in the 1970s by Robert McNamara, then President of the World Bank (Baah-Dwomoh 2016). It was in 1973, during the World Bank's board of director's meeting in Nairobi, that the worrying condition of the rural poor in the developing countries was thoroughly discussed and a rescue approach was proposed for poverty alleviation. The rescue approach, proposed for eradicating poverty amongst the rural poor, was designed based on an integrated system for rural development specifically. The World Bank then advocated for rural development initiatives in the 1970s and specifically named the rural development as a strategy intended to develop the economic and social life of a particular group of people – the rural poor. The programme embraced the awareness campaign on the benefits of rural development amongst the rural poor who were seeking a better livelihood (World Bank 1975). Later in 1975, the World Bank fully adopted the rural development strategy which played a leading role in the Bank's lending during the 1970s and 1980s, which obviously influenced, in many ways, towards agricultural and rural development support. Most of these rural development initiatives assist the rural dwellers in many ways far beyond poverty eradication. It is for this reason that both the Government and international donor agencies consider rural development initiatives as the means of enhancing the economic and social life of the people in the rural areas, precisely the rural poor. Therefore, scholars have foreseen the wide coverage of the ample benefits linked with rural development to those searching for a livelihood in rural areas, including smallholders, tenants, and the landless. Even though, right from the onset, the prime aim of rural development initiatives has been the eradication of poverty and enhancement of the wellbeing of rural dwellers, it is very important to design such programmes not only to encourage production and raise productivity to increase food availability and incomes but also to improve the provision of the basic social amenities, such as health and education as well as infrastructure. Table 3.1 shows the summary of rural development in the decade hierarchy.

Table 3.1 Summary of rural development in decade hierarchy

No	Period	Related rural development approaches
1	1950s and 1960s	Introduction of modernised approaches which emphasise on technology transfer
2	1970s	Initiation of large-scale state development interventions and integrated rural development programmes
3	1980s	Associated with market liberalisation and attempts to roll back the state
4	1990s	Emphasis was on participation and empowerment within a context of diversifying rural livelihood opportunities
5	2000s	Introduction of poverty eradication initiatives, reinvigoration of smallholder agriculture, sustainable farming systems, and the location of producers within global value chains

Source: Baah-Dwomoh (2016)

Considering the scope of rural development strategies, it has covered far beyond any particular activity or single sector. A well-designed rural development initiative, either at the local, state, regional, or national level, ought to include a variety or combination of different activities, including projects or programmes to increase agricultural productivity and production; provide employment; improve health, education, and infrastructure; expand communication; and improve housing. Thus, considering the expected scope of rural development initiatives, experts and scholars have commonly posited that an effective rural development initiative would demand some form of coordinated development at the rural level, and, therefore, this led to the introduction of the concept of integrated rural development (IRD), which is a model that stresses the proper coordination of related sectors, the state, or region, at the local level. Considering its nature, the IRD has become a complex and multisectoral model, the success of which has been dependent on the interaction of multiple factors and the performance of different entities, whose integration is a necessary prerequisite to effective implementation.

3.4 Rural Development Models and Theories

There are quite a number of rural development models, and for that reason, it is, therefore, vital to examine the various models of rural development which have been practically tested in some developing countries. The most adopted rural development models have been presented by Ayichi (1995), including:

(i) Integrated rural development model
(ii) Sectoral development model
(iii) Urban development model
(iv) Industrial development model

3.4.1 Integrated Rural Development Model

The concept of this model seeks to develop the various sectors of the economy to be linked to the urban economy (Pinstrup-Aderesene 2002). Thus, the notion of this model aims at stimulating bonds between the farmland informal sectors for the rural economy. This model is usually prescribed by International Development Partners and Donor Agencies. This includes the World Bank and the United Nations Development Programmes (UNDP), amongst others. In addition, Ijere (1993) posited that the integrated rural development model virtually necessitates government–community cooperative partaking in enabling effective health-care services, education, basic social amenities, and rural infrastructure in the most harmonised and synchronised approach so as to extend the overall wellbeing of the rural dwellers. The integrated rural development approach is known by its distinct qualities, in such that rural development programmes are pursued holistically, hence embracing not only the rural areas but also the urban centres in a particular state.

3.4.2 Sectoral Development Model

The presenters and advocators of the sectoral development model posited that developing a selected area of rural life will eventually bring about the desired development in the community. Also, according to some scholars, this concept highlights the age-long struggles by some governments in the advanced world to concentrate attention in the development of the agricultural sector as a universal remedy to overcome the major challenges faced by rural dwellers and to achieve the rural development goal. Although the literature shows that focusing on agricultural development alone cannot bring about the desired development in rural areas, other relevant factors, such as political will and governments' huge investments in the education sector, health, transport, and commerce, credible electoral process, and fight against corruption, hunger, and injustice, amongst others, will perceptibly bring about the desired rural development (Wholey 1982).

3.4.3 Urban Development Model

The urban development model is a concept that encourages the development of capital projects in the urban areas. Principally, the model is based on the methodological premise assumption that the benefits of urban area development will trickle-down to the rural areas and further reflect and arouse growth and development in the rural areas. In contrast, Roundinell et al. (1975) posited that the concept of this model has failed practically in many third-world formations largely due to over-concentration of development projects in the urban centres resulting in rural–urban migration. Grindle (1980) further stated that the failure caused by this concept is obviously accountable for the challenges in the urban centres, such as overpopulation, increase in crime, poor sanitary conditions, low life span of social amenities/ facilities, high cost of living, security challenges, diseases, and unemployment.

3.4.4 Industrial Development Model

The concept of the industrial development model postulates that, for a rural development programme to be successful, industrialising the economy is a precondition. Conceptually, the industrial development model is based on the assumption that industrialising the rural area would further create employment opportunities for the people and also attract other social amenities, such as water, electricity, road, health, education, and recreational facilities, amongst others (Todaro 1995). Unfortunately, due to poor management and a lack of sufficient funding, industries in most African countries are largely short-lived.

3.5 Funding Approaches for Rural Development in Africa

Generally, there are a number of approaches which have been adopted by international donors and the government to support rural development in Africa over time. Most of these approaches were initiated based on the influences of the technology transfer which is predicted to have multiple effects, such as the eradication of poverty by means of development focused on rural areas, to an integrated approach for such rural development (Baah-Dwomoh 2016). When criticism began due to the weaknesses identified with the integrated rural development approach, the concept of market liberalisation was then introduced, which included the structural adjustment programmes that serve as a direct support for agriculture and rural development. From the 1980s, the agricultural support programmes mainly for rural development by both the governments and donor agencies started declining. Also, from the 1990s, there was a shift from the integrated rural development to schemes. Since then, donor support for rural development, especially for agriculture in Africa, was spread across various agricultural activities, such as research, extension, credit, seeds, and policy reforms, in rural spaces. Consequently, the funding approach for rural development programmes was changed and restructured into a community-driven development. This concept mainly focuses on community participation, empowerment, as well as broadening the horizon of rural livelihood prospects (Baah-Dwomoh 2016). Since the introduction of the community-driven development (CDD) in the mid-1990s, the concept has proven to be reliable for rural community development amongst non-governmental organisations, international donors, and development banks. Initially, the concept of CDD was influential because it recognised the ample contribution of large-scale, bottom-up, and demand-driven poverty alleviation programmes towards supporting the formal capacity of rural communities. Amongst the well-known CDD projects in Africa, they include the Benin National Community-Driven Development Project, the Nigeria Second National Fadama Development Project II (NFDPII), and the Morocco National Initiative for Human Development (INDH). A part from that, there have been efforts for intensive forms of community participation in Africa by donor agencies. These include multilaterals, such as the International Fund for Agriculture Development (IFAD), the Africa Development Bank (AfDB), the European Union (EU), the Food and Agriculture Organisation of the United Nations (FAO), the UN Capital Development Fund (UNCDF), and the World Bank, and bilateral donors, such as the French Agence Française de Développement (AFD), the Department for International Development (DFID) of the United Kingdom, and the Canadian International Development Agency (CIDA), who have used CDD-type approaches for a long time as well, as part of their sustainable livelihoods and integrated basic needs development assistance in developing countries. The Swedish International Development Agency (SIDA) and Danish International Development Agency have also used CDD principles in the mandate of a rights-based approach to the development projects they fund. Additional modern approaches in funding rural development in Africa include Development Policy Loans with agriculture components or with agriculture as the main target sector, environment and natural resource management, infrastructure-oriented competitiveness enhancement programmes, and sector-wide approaches for agricultural development that aim to support the single sector policy and also expenditure programmes in support of the agricultural sector. Amongst all the aforementioned strategies, approaches, and rural development programmes, still, literature evidence has proved that there exist other approaches, especially those with community participation, that practise the harmonised or combined approach and that seem to be having a good impact on the rural community where they are being implemented.

3.6 Contemporary Approaches for Rural Development in Africa

Although the integrated rural development projects of the 1970s and 1980s were characterised with various issues, development experts and practitioners continue to argue that emphasising on agricultural sector alone without dully considering other complex associated sectoral linkages of the economy could result in logical bias in determining the parameters for effective rural development (Baah-Dwomoh 2016). Rural development is accepted as much broader than agricultural development, because some other activities associated with rural development provide a substitute to agriculture and serve alternative sources of income and means of survival to the rural poor. As a whole, agricultural development could still serve as a main contributor of rural growth up to the present time, and it continues to serve a significant role in poverty reduction.

3.7 Sustainable Agriculture and Rural Development (SARD)

In 1992, the United Nations during its Conference on Environment and Development which was held at Rio de Janeiro takes on certain measure to serve as action in three important areas, namely, sustainable agriculture and rural development (SARD), combating desertification and drought, and integrated planning and management of land resources. Since then, these three sectors have been considered as the major areas of concern for rural and agricultural and rural development. They equally serve as the basis for planning and implementing agricultural and rural development programmes during the 1990s decade and beyond. The United Nation Commission on Sustainable Development (UN-CSD) later merged the three key areas into a single cluster termed “land and agriculture”. The main target of the SARD is to ensure sustainable development of agriculture and allied economic subsector planned and established alongside with broader investment determination in rural areas and to continue enhancement of rural livelihoods, ensuring food security and a more coherent and rightful utilisation and conservation of the limited land resources for present and future generations. SARD emphasised for all member countries to take the opportunity and establish functional development plans and policies to ensure sustainable steady food production and security. In particular, governments of African countries consider the SARD initiatives as a privilege to promote agriculture and rural developments and functionalise the New Partnership for Africa’s Development (NEPAD) which they have created which subsequently gave the chance to prioritise agricultural development programmes. Afterwards, the African governments established the AU NEPAD/CAADP initiative that portrays the commitment of AU member countries towards solving issues affecting implementation of rural development programmes, agricultural growth, and food security.

3.8 Challenges and Opportunities of Rural Development in Africa

Developing the rural areas involves series of actions in various sectors which may take the form of volatile changes; thus rural development generally is a slow and complex process (Kelles-Viitanen 2005). The developmental process depends on both internal and external factors such as privatisation and globalisation. Whereas climate change, population growth, and HIV and other related killer diseases are some of the major challenges of rural development in Africa, climate change has obviously become a great challenge to our generation spreading its impact to almost every society across the globe. The impacts largely depend on certain climate factors' changes; also it depends on the country's societal, traditional, cultural, ecological, and economic backgrounds. The impacts of climate change are already being practically seen in many economic sectors across different regions. According to Nzeh and Ajayi (2003), the major challenges facing humans today originate from changes within the ecosystem. Climate change is a threat not only to the sustainable development of socio-economic activities of countries but to the totality of human existence. Much of the literature on the economic impact of climate change directly reflects on agricultural activities and human health, yet the impacts of climate change on human life goes beyond that (Surender and Amsalu 2012). All the determinants of economic, social, and environmental sustainable developments were believed to be affected by sustainable developments. Some scholars are even of the opinion that climate change is the geneses of all problems to show its irreversible impacts (Griffin 2005). African countries that are experiencing the impacts of climate change have since taken adaptation measures. Funding these adaptation initiatives required diversion of substantial resources which is another drawback to the economic progress efforts by Africa. According to Collier and Ong (2008), increasing climate variability is already affecting crops, livestock, water resources, land, forests, and biodiversity. In terms of projections, uncertainty pervades climate change projections for Africa. The rapid population growth in Africa fosters a huge challenge to rural development, agriculture, and food and water security. In addition, rapid population growth contributes enormously to unemployment issues. Accordingly, it leads to higher rural populations, extremely rapid urbanisation, and high dependency rates, which in hard-hit countries are accentuated by high adult mortality from HIV and AIDS.

3.9 Conclusion

This is a conceptual study aimed at assessing the challenges and opportunities of rural development in Africa based on related literature. In Africa, statistical evidence shows that over 80% of the population of most African nations reside in the rural areas. The mission of realising the desired rural development in Africa has remained a critical issue. The rural areas have been continuously and consciously exploited and underprivileged to the benefit of the urban areas, and the nature of most rural development projects in Africa has unrelentingly been influenced by politics. In the long run, this has led to a low life expectancy and high infant mortality. The majority of the rural dwellers consider these conditions as harsh forcing massive migration into urban areas in search of employment opportunities and better life condition for survival. Agriculture has been the most prominent occupation among major rural dwellers in Africa, yet rural development is accepted as much broader than agricultural development, because some other activities associated with rural development provide a substitute to agriculture and serve alternative sources of income and means of survival to the rural poor.

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Chapter 4
Regenerating the Pearl of the Pacific: A Destination Capitals Approach to Acapulco's Tourism Development

Mark Speakman and Alejandro Díaz Garay

Abstract Mexico's tourism authorities once exploited Acapulco's resources, or capitals, to such an extent that it became a tourism phenomenon, often referred to as the 'Pearl of the Pacific'; however, ignorance, neglect and competition propelled the destination into a state of decline, and it appears that the ability to exploit its capitals has now dwindled considerably. Sharpley (2009) offers the 'destination capitals model of tourism development', which provides a means to assess these capitals in conjunction with a destination's community needs, development opportunities and external threats. Utilising the case study research method and the associated data collection methods of semi-structured interviewing and document analysis, Sharpley's model is applied to Acapulco in order to determine the current state of its tourism industry and to consider the destination's potential to end the chronic pattern of decline and instigate a process of regeneration. It was concluded that while Acapulco's capitals fail to be exploited for various reasons, it does hold promise due to its impressive legacy, the underlying quality of its natural environment and the potential associated with several undeveloped cultural resources; nonetheless, any hope of regeneration requires a consolidated effort on behalf of all stakeholders to strengthen each capital. The findings offer insight regarding the viability of the model as a development framework for a destination in decline. In this sense, its suitability as both an academic and practical method of analysis is supported.

Keywords Acapulco · Destination capitals · Destination decline · Destination regeneration · Tourism development

M. Speakman (✉) · A. D. Garay
Autonomous University of Guerrero, Acapulco, Mexico
e-mail: mspeakmanuagro@outlook.com

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4.1 Introduction

Sharpley (2009) acknowledges the economic, environmental and social concepts that underpin the paradigm of sustainable development yet stresses that theoretical ambiguity and practical limitations make the approach incompatible with tourism. He thus offers a 'destination capitals' model as a development framework, which involves exploiting the sociocultural, environmental, human, political, economic and technological capitals (resources) of a destination within the bounds of local and external development opportunities. In spite of the model's capitalistic overtones, sustainability is intrinsic to the process, but in this case, the destination is able to determine its own objectives rather than catering for an externally imposed set of directives. The main objective of this chapter is to apply and test Sharpley's model on a tourism destination in decline, one that is in particular need of redevelopment and regeneration. Consequently, the Mexican resort of Acapulco was chosen to serve as the case study, the once proud 'Pearl of the Pacific' now firmly entrenched in what has become a long-term tourism crisis. The resort's decline is manifested in various forms, such as a collapse of international tourism, an abundance of low-status domestic visitors, poorly maintained hotels and attractions, the appearance of solid waste in the streets and on the beach, inadequate infrastructure and grave social problems. Yet, as will be seen, there is potential for improvement if those responsible for Acapulco's tourism development are able to efficiently exploit the destination's capitals. This chapter is structured as follows: Sharpley's model is introduced, and the history of Acapulco as a tourism destination is briefly recounted. The chosen methodological approach is then explained, and the model is applied to Acapulco. Thereafter, the final section discusses the appropriateness of the model as a framework for development planning in Acapulco and other destinations in decline.

4.2 A Destination Capitals Model of Tourism Development

Sharpley (2009, p.148) suggests that a tourism destination is a 'capitalist endeavour', similar in concept to a business corporation. In both cases, resources are employed to produce products which are sold for a profit, and it is ultimately the responsibility of management/the destination authorities to pursue a strategy that enables the utilisation of capitals in a manner most beneficial to that particular business/destination. In order to provide direction in the formulation of development plans, business corporations typically present a mission statement, conduct an internal audit of their capabilities and provide an analysis of their external environment. Sharpley's model (Fig. 4.1) represents an opportunity for practitioners within a tourism destination to perform a similar process so that suitable strategies can be established.

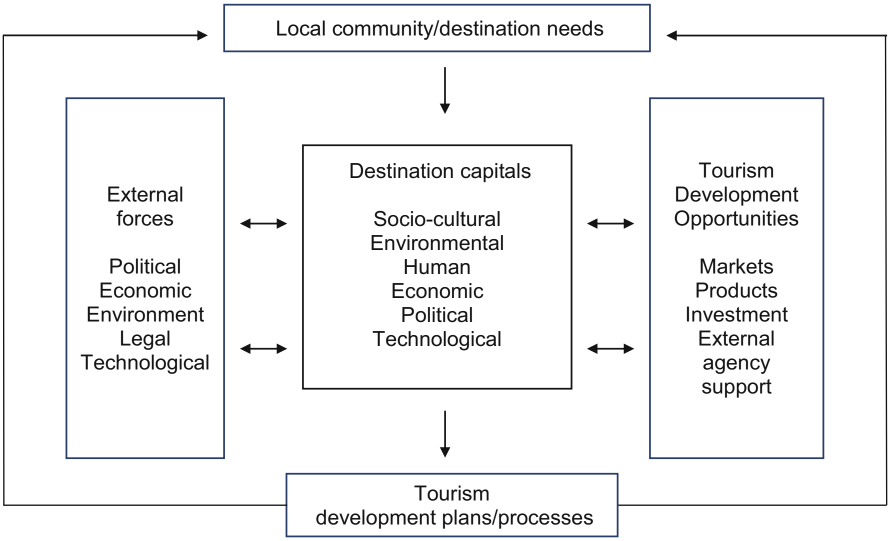

Fig. 4.1 Destination capitals model of tourism development. (Source: Sharpley 2009)

4.3 Local Community/Destination Needs

The authorities must decide what is being sought from tourism development with respect to local needs. This usually concerns matters such as economic diversification, foreign exchange or the generation of employment opportunities and is an important consideration before decisions are made regarding what type of tourism product to offer and which markets to pursue.

4.4 Destination Capitals

4.4.1 Sociocultural Capital

Sharpley (2009) prefers to adopt the term 'sociocultural' capital to envelop the social and cultural aspects of a tourism destination but does recognise that social and cultural resources are usually regarded as separate, individual categories of capital. Accordingly, this chapter will regard them as independent groups, interconnected in the manner that all of the capitals are linked, but meriting a distinct analysis. As such, social capital is described as a 'slippery concept' (Jones 2005, p.303), having no commonly accepted definition but generally referring to the resources constructed by means of mutual networks that members of the community can utilise (Macbeth et al. 2004), which is manifested in a collective effort to strive towards certain goals. According to Thammajinda (2013), community involvement in tourism development serves to create social capital as it promotes coordination and collaboration and allows communities to facilitate opportunities that enhance community spirit. Meanwhile, tourism-related cultural capital refers to the tangible and intangible manifestations of the destination community's historical and contemporary achievements: Tangible cultural capital refers to cultural heritage in the form of historic buildings or works of art, while intangible capital is evident in events such as festivals or within the traits of a particular lifestyle (Sharpley 2009).

4.4.2 Human Capital

Human capital in tourism concerns the levels of knowledge, education and skills present in the destination population that serve to contribute to the development of tourism (Bennett et al. 2012, p.8).

4.4.3 Environmental Capital

Environmental capital refers to the natural resources of an ecosystem. In many cases this is the essence of the tourism experience, and, as such, it is vital that this resource is sustained as part of tourism policy. It includes not just the natural environment but also the built environment, which may include iconic buildings and constructions or a general infrastructure that is pleasant and adequately maintained.

4.4.4 Economic (Financial) Capital

Economic capital is necessary for tourism development as it supports the processes necessary to improve education, training, infrastructure, planning, promotion and the maintenance of environmental and cultural resources (Bennett et al. 2012). Without the requisite financial resources, tourism authorities are unable to operationalize their strategies and compete with alternative locations.

4.4.5 Political Capital

A destination's political capital determines the extent of power it holds in relation to external actors, and, as such, it ultimately decides which authority controls the future development of the destination. Consequently, local tourism authorities able to exploit political capital are generally able to direct development, whereas those unable to utilise this resource tend to be undermined and governed by state or national bodies (Sharpley 2009).

4.4.6 *Technological Capital*

Information technology (IT) has become ubiquitous in the tourism sector and is considered an essential element of destination competitiveness (Buhalis 2003; Poon 1993; Sheldon 1997). It has improved the operating efficiency of tourism businesses and has changed the relationship between potential tourists and tourism businesses (Sharpley 2009). Consequently, the learning of IT-based skills and an online presence are required to improve competitiveness in a destination.

4.5 Tourism Development Opportunities

Relating a destination's development opportunities to its capitals forms the basis from which to prepare tourism plans. Opportunities refer to current and potential markets and market segments, existing products and alternate possibilities and likely investment and support in both the domestic and external environment.

4.6 External Forces

External factors often influence the degree to which capitals are exploited. These can range from national government policies to international trade agreements and can either restrict or permit the measures necessary for resource development.

4.7 Acapulco Tourism History

Acapulco has passed through four identifiable phases since its advent as a tourism destination in 1927.

4.7.1 *The Rise of Tourism (1927–1952)*

The opening of a highway in 1927 which vastly improved links with Mexico City provided the catalyst for tourism in Acapulco. Previously, it had been a 'relative backwater' (Niblo and Niblo 2008, p. 32), a once successful port city that had fallen into decline. However, it was not until the presidency of Miguel Aleman in 1946 and his determination to further develop the tourism industry that Acapulco began the process of 'internationalisation' (Valenzuela and Coll-Hurtado 2010: 167) and its transformation into the glamorous, internationally renowned 'Pearl of the Pacific'.

4.7.2 The Golden Age (1955–1980)

Acapulco became fashionable with the Hollywood ‘jet set’, and its position as leader of the North American market was further consolidated by the Cuban revolution of 1959 (Ramirez 1986). Physical evolution continued in the form of the Golden Zone, a conglomeration of hotels, restaurants, bars and shops, which stretch for five kilometres along the coast. Many of the newly built hotels were bought or leased by transnational chains, thus providing the predominantly North American visitors with quality accommodation. Nonetheless, the golden age was to be compromised a decade later as Mexico’s newly established tourism poles, in particular Cancun, provided previously unheard-of competition and environmental deterioration began to discourage both international and domestic visitors.

4.7.3 Slow Decline and an Attempt at Reinvention (1980–2006)

As Acapulco’s allure gradually diminished, the transnational hotel chains, vital in securing linkages and attracting international clientele, began to abandon the destination. Meanwhile, the new owners failed to provide the required maintenance which resulted in a marked deterioration in the standard of services. As a consequence, international tourism steadily decreased as alternative options became available to the notoriously fickle travel market. In an attempt at reinvigorating the international market and hoping to attract both affluent and second residence tourists to Acapulco, the state government of Guerrero initiated the development of the Diamond Zone in the south part of the destination in 1992 (Carrascal and Perez 1998). The area is now resplendent with luxury hotels and condominiums, golf courses, commercial shopping malls and recreational areas, but success has been limited and the area’s development has been criticised for being an economic failure and environmentally inappropriate (Avilez et al. 2012).

4.7.4 Rapid Decline and Crisis (2006–2017)

Mexican President Felipe Calderon’s War on Drugs campaign provoked a marked upsurge in criminal activity throughout the country, but particularly in Acapulco, a city which is both a transport route and a selling point for narcotics. This significantly accelerated the rate of the destination’s decline, with the number of registered international visitors falling from 131,188 in 2006 to 10,569 in 2015 (SEFOTUR 2016). In short, Acapulco’s reputation has descended from a golden era of charisma and prestige to a somewhat jaded resort, lacking in facilities for the modern tourist and one which cannot offer security for its visitors. The destination’s decline is attributable to both internal and external factors, yet a large portion of the blame must be laid with the tourism authorities for their complacent attitude.

> We thought the tourists would always continue coming here. We thought we were unstoppable. We did not think ahead at all. We were frozen in the 1950s and 1960s. They thought in those times that tourism would continue the way it was. The sector didn't adapt to what was coming in the future. (Participant 3, personal communication, January 19, 2016)

The Diamond Zone was an attempt at reinvention, but the project has not been as successful as the authorities had hoped for, and the proliferation of luxury condominiums and gated communities does not contribute significantly to Acapulco's tourism revenues. The decline has worsened since 2006 to the point in which international tourists are barely noticeable in the resort.

4.8 Methodology

The research adopted a qualitative methodology, with the case study method employed as a means to explore the relevance of Sharpley's model within the setting of the Acapulco tourism industry. A purposive sampling technique was adopted which recognised a total of 30 possible interview participants, all of whom were stakeholders in Acapulco's tourism industry. Eighteen of those identified gave their permission, and consequently the interviews were conducted in various locations in Acapulco between January and May, 2016. Various documents available online and in Acapulco's historical archive were reviewed as a means to support the primary data, and finally the data were analysed by means of the coding techniques proffered throughout the literature (Jennings 2010; Miles et al. 2013).

4.9 Destination Capitals Model Applied to Acapulco

The following section will apply Sharpley's model to Acapulco. It begins by examining the needs of the destination and local community and then assesses the present condition of each capital in turn. The potential of each capital to be exploited and form development opportunities is then considered before possible markets, products, sources of investment and external support are determined. A brief contemplation of the external forces that can serve to both jeopardise and encourage development brings the section to a conclusion.

4.9.1 Local Community/Destination Needs

Acapulco's local authority is aware that measures need to be taken to deal with the serious issues affecting the community and that strategies need to be devised with the aim of reviving the struggling tourism industry. Consequently, the municipal development plan of 2015–2018 (Ayunamiento de Acapulco 2014) lists a number of policies that the authority wishes to implement, which inadvertently reflect the necessity to exploit Acapulco's capitals in order to attain the transformation that the region requires. For example, the idea to establish a municipal tourism advisory committee, promote resident (and children) tourism awareness campaigns and develop tourism programmes for residents of Guerrero is related to social capital. The plan to promote cultural, gastronomic and sporting events, conferences and festivals aims to improve cultural capital, while the intention of improving waste collection services and cleaning the beach and sea aspires to enhance environmental capital. Meanwhile, the notion of setting up a training workshop to specifically focus on the attitude of tourism service is directly linked with human capital, and the intent to negotiate with the federal and state governments in an effort to improve infrastructure, communications and public services endeavours to heighten political capital. The policies forwarded in the municipal development plan serve to emphasise various areas in which Acapulco's capitals are clearly lacking and therefore not contributing sufficiently to the needs of the community and destination. The following section will consider each capital individually and assess the extent to which they are either being exploited or insufficiently utilised by the authorities.

4.9.2 Destination Capitals

4.9.2.1 Social Capital

Since Acapulco began its development as a tourism destination, there has been a considerable chasm between its residents and those responsible for and benefitting from development. Indeed, federal, state and municipal governments have been repeatedly criticised for a negligent attitude towards the local population (Gomezjara 1974; Sackett 2010). Perhaps the most explicit example of this is the forced displacement of whole communities that occurred between the years 1928 and 1980, "a process in which the interests of hotel developers and tourists were paramount, and those of the people of Acapulco were secondary" (Sackett 2010, p. 161). At the same time, the chronic inability to accomplish the directives of tourism-related plans (Speakman and Diaz Garay 2016) has resulted in inadequate services, poor infrastructure and scant community funding in a city in which one in three residents are classified as being destitute (Kastalein 2010, p. 320). The desperation arising from such poverty has led to an increase in crime and opportunism which, in turn, has affected the social cohesion within Acapulco's community, resulting in a situation in which attempts to cultivate forms of community cooperation in respect of tourism development are often met with resistance by a society which is inherently fearful, cautious and sceptical. Meanwhile, those tourism-related committees that do exist in Acapulco (facilitated by Mexico's General Law of Planning which was established to support community involvement) tend to be discreet and closed affairs attended by the same select few:

> The General Law of Planning is about the participation of society- so that they can help make decisions, but what happens in reality? Not everybody participates-they are groups which are very closed. There doesn't exist a culture of participation. (Participant 12, personal communication, April 6, 2016)

4.9.2.2 Cultural Capital

Acapulco possesses substantial cultural heritage. For example, several attractions which convey the destination's past, namely, the Fort of San Diego (which contains Acapulco's Museum of History), the Palma Sola archaeological site and the Diego Rivera wall mural, are located in close proximity to the clifftop of La Quebrada, from which locals dive into the sea below, and the Los Flamingos hotel, former residence of Hollywood icons Johnny Weissmuller and John Wayne. Meanwhile, a significant intangible cultural presence is provided by Acapulco's sense of place, or terroir (Smith 2015), manifestations of Asian, African and South American ancestry in artisan products available in local markets and in a gastronomy renowned for dishes such as *pescado a la talla*, *ceviche* and *pozole*. Nonetheless, promotion efforts lack intensity. That is, Palma Sola, the Fort of San Diego, Rivera's mural, Los Flamingos and La Quebrada rely chiefly on word of mouth promotion, and while efforts are occasionally made to promote Guerrero's gastronomy, it tends to have a limited impact and the region is not particularly known for this aspect of its culture. The reluctance to diversify the tourism product gives credence to a common perception among many stakeholders that the authorities are for the most part only concerned with offering Acapulco as a beach destination:

> Unfortunately, they only want to promote the sun and beach product. Even though there are problems they don't diversify. Why don't they do it? The plans have never thought to develop Acapulco as a cultural destination. It's always been a beach destination. The Federal Government decided that this was no good for Acapulco. (Participant 2, personal communication, January 13, 2016)

4.9.2.3 Human Capital

Historical analysis demonstrates that Acapulco's tourism development has adversely affected the community leading to numerous social issues. At the same time, local workers' needs have been similarly disregarded. For example, throughout the destination's golden period, the majority of hotels were managed by foreigners, and in many cases, only people of a white complexion were allowed to work in the reception area of hotels.

> Tourism for a long time here was seen as an 'elitist' activity. We were always told that it's an activity for 'nice' people; there is no room for ugly, poor people. (Participant 5, personal communication, February 10, 2016)

While such elitist, racist overtones no longer appear to be dominant in Acapulco, discrimination still exists to a certain extent, and a large number of workers in the tourism industry lack the motivation for self-improvement, feeling that their efforts will ultimately be without reward. For the majority of these employees, work is a necessity to afford basic food, housing and medical care; hence, there is scant interest in job-related self-improvement, and those training courses that are provided are usually attended through obligation (Universidad Autónoma de Guerrero 2014).

To make matters worse, those that do exhibit potential appear to be leaving Acapulco for other Mexican destinations in search of a higher salary, better tips and greater opportunities for progression:

> There is a flood of talent is leaving Acapulco. Youngsters who can't develop locally go to other destinations. They go to Cancun, Riviera Maya, Mexico City, Puerto Vallarta. This is a problem we have. (Participant 8, personal communication, February 24, 2016)

At the same time, a large proportion of Acapulco's tourism businesses are guilty of failing to implement policies designed to improve employees' motivation and work skills. Often, training courses are provided solely to meet legal requirements, rather than as an investment to improve the business's human capital. Combined with the pessimistic attitude of many employees, this results in a situation in which neither the business nor the employees appear to reap any significant benefits from such activities and the general malaise enveloping the workforce continues to prevail.

4.9.2.4 Environmental Capital

Acapulco's natural capital is the destination's greatest resource, having served as its selling point for decades. The Bay of Santa Lucia (or Acapulco Bay) and surrounding mountainous rainforests offer a memorable view, while the beach continues to be the main attraction for the sun, sea and sand segment. Meanwhile, the nearby lagoons of Tres Palos and Coyuca, Veladero National Park and Roqueta Island add to the overall tropical ambience of the destination. Unfortunately, this abundance of environmental capital is diminished by the sight of garbage strewn throughout the streets and the beach and also the contamination of the sea with sewage and toxic metals. Though visual pollution was becoming evident during Acapulco's golden era, it became a significant problem during the 1980s, contributing to the initial decline of international tourism, as explained by Valenzuela (2008, p. 217): 'They began to notice the rapid transformation of the natural and urban landscape, increasing garbage in streets, beaches and also the pollution of the bay. . .'. Those guilty of illegal waste disposal include businesses, hotels, tourists and local residents. A particular problem emanates from the shanty towns which have developed in the surrounding hills as garbage accumulates around these settlements and is swept to the beach and sea by way of several rivers, especially during the rainy season (Dimas et al. 2015).

Furthermore, the built environment also adds to the sense of environmental decay. The abundance of high-rise hotels situated along the Golden Zone's seafront obstructs the view from the coast road, while the failure of the owners to maintain the hotels, as was mentioned previously, has resulted in a proliferation of dilapidated, somewhat ugly buildings. At the same time, other attractions such as Papagayo Park and the Dolphin Aquarium appear outdated and neglected. Particularly noticeable in high season is the inability of the urban infrastructure to cope with the volume of tourists, which inevitably culminates in congested traffic, crowded pavements and the resultant visual, air and noise pollution. In addition, there exist several locations that could conceivably function as environmental attractions, yet they remain undeveloped. One example is Veladero National Park, an ecological reserve that harbours the potential to become a sustainably viable attraction but instead appears to be disregarded, left to languish out of sight of the tourists and suffering from a degree of environmental damage caused by several years of illegal human settlement.

4.9.2.5 Financial Capital

Acapulco's tourism industry was built upon state, local and foreign financial capital which served to create the conditions for the mass tourism that was to follow (Sackett 2009). Nonetheless, the destination's change of circumstances from 'golden era' to 'slow decline' led to a significant downturn in levels of investment, now visually manifested by the aged and shabby hotels, deteriorating attractions and closed businesses which affect the quality of Acapulco's built environment. The situation has decidedly worsened since the destination entered into a period of rapid decline in 2006, which has resulted in the majority of international tour operators and airlines withdrawing from Acapulco.

> Since 2006 strong investments have gone down a lot. It's obvious. When there are no guarantees, when a destination does not have direct flights- this is a big problem. So, investments just disappear. (Participant 15, personal communication, May 2, 2016)

Meanwhile, federal, state and municipal funds designated for tourism development are often compromised as money is extracted for personal gain; consequently, projects outlined in development plans are done cheaply or abandoned. Additionally, promotion strategies lack the necessary finance required to be fully effective because the funding for marketing projects, levied from hotel room tax, has been negatively affected by the frequent failure of Acapulco's hotels to reach capacity.

4.9.2.6 Political Capital

From the period of Miguel Aleman's presidency (1946–1952) until the 1980s, Acapulco's local authority and businesses possessed a substantial amount of political influence. Notwithstanding, as Acapulco's popularity began to wane, so too did its political capital. That is, interest from the federal government gradually diminished as the new tourism growth poles began to attract international tourists. Consequently, the political favouritism previously enjoyed by Acapulco's prominent politicians and corporations began to disintegrate, thus weakening the influence of the destination and provoking the initial decline in public and private investment discussed above. The extent of Acapulco's political capital is also influenced by the occasionally frictional relationship between its tourism organisations and their counterparts in the state and government offices, as explained by an interview participant:

> The one that has power here is the State Secretary of Tourism. The Secretary of Tourism has a plan, a programme, and they coordinate tourism policy throughout the state. They provide funds to the Municipal authorities. A Municipal authority like Acapulco will have a tourism plan- a list of projects, but the State gives what it thinks. In my opinion, the State wants to run everything and they do not give the local council enough autonomy or funding. We do not have enough resources. (Participant 7, personal communication, February 15, 2016)

4.9.2.7 Technological Capital

When considering a destination's technological capital, it is not simply a question of considering general access to information technology (IT), but to assess whether it is actually being used efficiently to communicate with current and potential markets and stakeholders in general. Correspondingly, access to IT in Acapulco is not regarded as being particularly problematic; instead, the issue that emerges is one of insufficient utilisation, mostly due to the failure of the authorities to develop the innovative culture that is required to fully embrace the potential that IT has to offer. Consequently, despite some individual examples of successful initiatives, such as the *Acapulco Puede* (Acapulco Can) application developed by the local authority in 2012, the evidence points towards a widespread nonchalance regarding the exploitation of IT throughout the Acapulco tourism community.

> The tourism industry here just moves from day to day. Most managers and workers in hotels and restaurants are too busy trying to meet costs than to think about what IT might have to offer. We need some training workshops to show them. (Participant 14, personal communication, April 12, 2016)

4.10 Tourism Development Opportunities

Relating a destination's market opportunities to its capitals forms the basis from which to develop tourism plans. At this stage, it is necessary to establish the extent to which each capital should be exploited and what can be done to revitalise ailing capitals. The analysis of Acapulco's capitals in the previous section established that its environmental and cultural resources hold significant potential. Rich environmental capital was the chief factor contributing to Acapulco's historic success as a tourism destination, but it has been undermined by the sight of shabby, neglected buildings and discarded solid waste that pollutes the streets, beach and the sea. The abundance of solid waste in particular serves as a visual reminder of the negative social issues affecting Acapulco, reflecting a certain level of ignorance and disregard from the community towards authority, the environment and tourism in general. In an attempt to amend this situation, community organisations, associations and networks need to be established, or reorganised, so that residents are permitted and encouraged to participate in tourism decision-making, operation and management, thus facilitating the improvement of social capital (Moscardo 2012). At the same time, efforts must be made to enforce environmental regulations in a business environment that is rife with corruption and bribery.

Inadequate waste disposal and poorly maintained buildings are not the only issues affecting the exploitation of Acapulco's environmental capital. Additionally, infrastructural weaknesses are abundant throughout the destination, particularly evident in the congested traffic and crowded walkways when the destination is busy during holiday periods. Rather than being a direct indication of a dearth in social capital, this issue is more so a consequence of the chronic failure of Acapulco's tourism/urban development plans to resolve the issues that have increasingly served to depreciate environmental capital leading Speakman and Díaz Garay (2016) to contend that the plans' rational philosophical approach is unsuitable for a system innately complex and unpredictable. Meanwhile, there are complaints that the destination's other significant resource, cultural capital, is being overlooked by the tourism authorities. Municipal decision makers, however, insist that the reason for this situation is a lack of available finance; that is, they stress that they are aware of the potential of cultural resources to attract new markets, yet the economic resources to develop these (and other) capitals are not available. This dilemma reflects the limitations of financial capital in Acapulco and suggests that any efforts to embark upon processes designed to enhance the destination's cultural capital require that the authorities are adept at exploiting financial capital beforehand; however, to increase financial capital, it is first necessary to improve social, human and technological capital so as to attract the attention of investors. In other words, Acapulco must resolve its chronic, internal social issues before it can hope to raise levels of financial capital and political capital and eventually exploit the opportunities associated with cultural capital, a sentiment expressed by an interview participant:

> You have to sort out your city, not just be looking for money from the Federation. Do your bit. If we can become a top-class destination again then our political influence will grow. The Federal Government and future investors must see that we are worthy of their attention. At the moment, they just see a mess. We must fix this. (Participant 11, personal communication, March 16, 2016)

This section established that although particular destination capitals may possess significantly more scope for development than others, all capitals are interlinked to various degrees. In the case of Acapulco, environmental and cultural capitals are recognised as having definite potential, with opportunities for development prevalent throughout the destination. Notwithstanding, in order to exploit these prospects, the destination must first initiate projects to improve its other capitals, particularly social capital, which, in a theoretical sense, is the root from which the other capitals will flourish if attended to correctly. The following section will review several development opportunities which are appropriate for Acapulco's destination capitals.

4.10.1 Markets

Mexico City and its surrounding metropolis remains the most vital domestic market for Acapulco due to the relatively short period of time required to travel from one to the other. However, it is only during Mexican national vacations and certain weekends that hotels operate at full capacity and businesses achieve substantial profit; usually Acapulco is quiet, with the majority of amenities and attractions struggling to sustain their activities over time.

> Here, the authorities say we had an excellent weekend- 80% full; then on Monday it is 6%. There is no equilibrium point. (Participant 1, personal communication, January 11, 2016)

Consequently, the destination capitals need to be exploited in a manner which stimulates consistent visitor numbers, with strategies being required which would entice the inhabitants of the Mexico City metropolis and other domestic markets to visit more frequently and to extend their length of stay. However, the problem is not limited to the shortage of visitor numbers; another issue that has arisen is the decline in the purchasing power parity of Acapulco's domestic visitors. That is, it is increasingly common for tourists to reside in illegal establishments and obtain all their necessities at local convenience stores and supermarkets, hence earning the label 'Walmart tourists' (Fausset 2013). As a result, it has become necessary to focus on attracting higher-spending visitors in the form of affluent Mexicans and international tourists, although this in itself is problematic because prosperous Mexicans wishing to visit Acapulco on a regular basis tend to buy second residence homes in the Diamond Zone, while foreign visitors have been discouraged by the insecurity issues present in recent years, to such an extent that there are now very few international flights arriving in Acapulco. To regain an international market, Acapulco's tourism authorities must negotiate with tour operators in a bid to revive air connectivity and subsequently produce promotion strategies designed to kindle interest among the destination's historic US market; nonetheless, efforts will be in vain unless two prevalent issues are dealt with: firstly, that the majority of the security problems are resolved and the US government withdraws its advisory that warns against travel to the state of Guerrero and, secondly, that the quality and diversity of the Acapulco tourism product is improved to meet the expectations of a new market. Suffice to mention that the US Spring Break segment was successfully targeted for a short period recently (Monterrubio et al. 2013), but has since disappeared due to an escalation in insecurity.

4.10.2 Products

As discussed in detail above, there exists much potential in Acapulco to exploit deteriorating or undeveloped environmental and cultural capital that would serve to diversify its tourism product. For instance, the destination's tourism authorities could seek to retain the traditional character of the destination as a mass market sun, sea and sand product, yet initiate projects to redevelop and modernise existing attractions and facilities that would appeal to a new, more discerning domestic and international market. Additionally, alternative tourism development projects, such as ecotourism and adventure tourism in Veladero National Park, heritage tourism at San Diego Fort or culinary tourism in the destination's cafes and restaurants, would appeal to further audiences currently not under consideration.

4.10.3 Investment

Acapulco receives direct public expenditure from the federal and state governments to improve infrastructure and public facilities, yet it is often criticised for being inadequate and susceptible to corrupt activities. Meanwhile, another problem that occurs is that projects are often impeded by protesting social and political groups who disagree with the plans for various reasons. At the same time, the overall negativity associated with Acapulco has resulted in the situation in which its appeal to private investors, both local and international, is limited (indeed, the inability to secure investment has culminated in a growing dependence on international aid, as will be discussed in the section below). Although Tourism Secretary Enrique de la Madrid Cordero recently spoke of a coordinated intergovernmental effort to attract higher-quality tourism (Sectur 2016), one participant suggested that such talk is merely rhetoric adopted to placate discerning voices.

> We do not want announcements of investment. They rarely happen. First, we want security and a stable climate. Then we want results. (Participant 17, personal communication, May 17, 2016)

To transform rhetoric into reality, the local authority must demonstrate that it is taking positive action to resolve the security issues affecting Acapulco and to strengthen each of its capitals. This process should gradually help to erase the present scepticism and attract the attention of those responsible for public and private investment.

4.10.4 External Agency Support

Mexico regularly receives international financial support for tourism and other initiatives. The majority of aid originates from Spain and has included specific support for Acapulco in the form of the Spanish Cooperation Fund for development which was designed to improve Acapulco's water and drainage network (Conan 2012). Sources of external funding are crucial in a destination such as Acapulco, lacking in investment and unable to exploit sufficient political and financial capital. Consequently, it is important that the local tourism authorities actively search for available support, even though the destination's high rates of corruption may ultimately discourage the source of potential funding. A method of transcending this issue is to ensure that any funding programme is managed by international agencies, as was the case with the recent successful Sagarpa-Patmir project implemented by agencies from Canada, Germany and France (see Universidad Autónoma de Guerrero 2014).

4.11 External Forces

Numerous 'forces' exist from outside the immediate sphere of a tourism destination that can both encourage and threaten the development of its tourism capitals. At present in Acapulco, the threats appear to be more substantial than the opportunities. For example, there are various political and economic factors which are either present or pose a risk, including political involvement in organised crime, US and Canadian travel advisories that warn against visiting Acapulco, US President Trump's proposal to build a wall separating the two neighbours (which, according to Cuskelly (2017), has already led to holiday cancellations), the restoring of US-Cuba diplomatic relations and the declining value of the Mexican peso.

Notwithstanding such threats, the Mexican government's national tourism plan of 2013–2018 provides guidance regarding the development of destination resources (or capitals), which could aid in the development and exploitation of Acapulco's destination capitals. For instance, it contains strategies designed to improve cooperation among the three levels of government in Mexico that would serve to advance political capital, while it also includes procedures devised to promote collaboration with educational institutions that would facilitate the spread of technological knowledge (Sectur 2013).

4.12 Conclusion

Sharpley's (2009) model offers a logical approach to tourism development, viewing the destination as a form of capitalistic enterprise possessing a number of resources which can generate sustainable economic and social benefits if exploited correctly. The main objective of this chapter was to consider the model's potential as a development framework for a destination in decline, with Acapulco providing an appropriate case study. Consequently, the application of the model demonstrated that Acapulco's tourism authorities are failing to exploit its tourism capitals, due largely to the chronic ineffectiveness of their planning and development plans, persistent resident discrimination, political instability and inability to attract sufficient investment. Nonetheless, it is concluded that the destination's environmental and cultural capitals offer the potential to stimulate a process of regeneration if exploited efficiently. To do so would require a coordinated effort on the part of the destination's stakeholders, in particular the local, state and federal tourism authorities, which focus on increasing the extent to which *all* of Acapulco's capitals can be exploited, as each is dependent on the others for its individual success. For example, failure to improve Acapulco's social capital would hinder the efforts evoked to exploit environmental capital and human capital, while an ineffectual attempt to increase political capital would impede endeavours to fulfil the potential of financial capital.

Sharpley's model provides a useful platform from which to evaluate the needs, capitals, opportunities and threats of a destination in decline, from both an academic and practical perspective. In an academic sense, it evades the incongruity that Sharpley (2009) associates with the sustainable tourism paradigm and permits the scholar to assess the exploitative capability of a destination from a pragmatic, capitalist perspective. Yet not only does the model present a logical basis for development, it can also be used as a specific framework from which to consider a destination that has passed through the stagnation process and is now in decline. In this respect, it encourages the observer to consider the historical processes, both internal and external, that have contributed to the destination's decline, permits contemplation of the factors that currently restrict capital exploitation and stimulates the advancement of possible solutions to the negative issues afflicting a particular destination. While it could be criticised for overlooking the intricate perspectives offered by emerging paradigms such as complexity theory and evolutionary economic geography, this was never the intention of the model. That is, it is offered as a commonsensical tool of analysis, a framework from which to develop tourism plans based on the advantages that the destination can offer and the circumstances of its internal and external environment. For this reason, it also functions well as a practical tool as it allows locally based practitioners to prepare a 'mission statement', undertake an 'internal audit' of the destination and plan appropriate strategies based on the objectives, the results of the capitals analysis and the opportunities (in terms of markets, products, external aid) and threats present at the time. In the case of Acapulco, the practitioners leading the development process would be those from the local municipal tourism authority although the lack of political capital present suggests that it would require close collaboration with their state and federal counterparts. Further research and debate is required to validate this research and elaborate on the appropriateness of the destination capitals perspective to assess a destination in decline and provide appropriate guidance for development. A longitudinal case study would be particularly welcome, one that could empirically demonstrate the initiation and development of strategies and policies derived from the application of the model to a particular destination and serve to identify the unfolding factors that contribute to or restrict its usefulness.

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Chapter 5
Relationship Between Women and Environment Toward Sustainable Development: A Case Study from Palestine

Abdelnaser Omran and Fulla Ismail Sharaf

Abstract Women have traditionally been the caretakers of the community, and their work has primarily met subsistence need set at the global level. Generally, women manage most of the household and agricultural activities. Livelihood has recently deteriorated due to many factors, such as poor environmental practices and resource management and environmental degradation, with an increasing number of men migrating to urban areas, which has thus resulted in the additional workload of women in rural areas. These issues lead to the following questions: (1) "What is the relationship between women and environment degradation?" and (2) "Will sustainability be achieved with women managing the environmental activities?" Accordingly, the present study primarily aims to investigate the current status of women's participation in the environment in Gaza City, Palestine. The quantitative approach was used to collect the data in the selected area of study. Out of the 95 sets of the questionnaires distributed, only 70 sets were completely returned and analyzed, yielding a response rate of 74.3%. Results corroborate that the majority of the female participants (62.9%) reported that they clean their surroundings daily in the Gaza Strip. Furthermore, the results contend that the large proportions of the participants were involved in different environmental activities, such as agriculture, solid waste management, sewerage, and management of waste resources in their living area. The recommendations made in light of enhancing women's involvement in protecting and managing the environment include the following: (i) The Palestinian women were required to participate at different level including national, regional, and international levels as regards environmental issues, such as preserving and protecting the nature, and (ii) the Palestinian women were required to obtain environmental education for sustainable development.

Keywords Women · Environment · Sustainable development · Questionnaire survey · Gaza · Palestine

A. Omran (✉)
Faculty of Engineering Sciences, Bright Star University, El-brega, Libya
e-mail: naser_elamroni@yahoo.co.uk

F. I. Sharaf
Palestinian Health Information Centre, Ministry of Health, Gaza Strip, Palestine

A. Omran, O. Schwarz-Herion (eds.), *Sustaining our Environment for Better Future*,
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5.1 Introduction

The world is unique for every human being, but, in general, women's lives greatly vary from those of men because of the patterns of socialization related to gender. In developing countries, women are affirmed to work more closely with their environment because, in most cases, they rely on the environment for their subsistence (Glazebrook 2011). Land and local resource-based developments are severely threatened due to environmental degradation (Wickramasinghe 1997). Without setting up new policies in place, the growing worldwide demand for resources will be threatening the world's environmental health to an unprecedented extent, whereby such new policies could have devastating implications for human development. Therefore, women and children can be very active participants in defense of the environment and stop, or even reverse, the degradation of our natural resources (Chelala 2011). Many studies have inferred that women play a massive role in protecting and preserving the environment. Dowlati and Hemati (2012) investigated the factors that affect the participation of rural women in the stable management of subterranean water sources in their study. They deduced that age, the number of children, and the literacy level have a significant positive relation with the participation of rural women in the stable management of subterranean water sources. Damisa and Yohanna (2007), who conducted a study on the role of rural women in management decision-making in farms, validated that the economic-social features of women are effective on the amount of their participation in village issues. Oloko et al. (2017) investigated the role of rural women's contribution in protecting the environment where they had deeply examined on how women in Nigeria particularly in the Makarfi Local Government Area (LGA) at Kaduna State can be interacted with their environment at different levels and how such interactions may contribute in protecting the environment. Sixty women shared their experiences and knowledge about the environment and how their traditional knowledge has helped them manage their interactions with the environment respectfully and sustainably. The participants reported that their activities under those capacities help them interact closely with the environment at different levels (Oloko et al. 2017). As part of their efforts to protect their environment, these women engage in activities such as tree planting, manure application, sustainable harvesting, and environmental sanitation to give back to the environment. Ghanian et al. (2008) looked at the role of rural women in preserving and reviving desert natural lands and verified that women play a role in preserving, reviving, and destructing activities in the region.

A fairly considerable number of studies on women activities and environments (Dankelman and Davidson 1997; Omran et al. 2006; Ghanian et al. 2008; Rahmani and Majidi 2009; Chelala 2011; Oloko et al. 2017; Akramolmolok and Narjes 2017) have contended that women are significant actors in natural resource management and major contributors to environmental improvement, protection, and conservation. Dankelman and Davidson (1997) observed that women play a major role in managing their natural surroundings and adopt several mechanisms to deal with the environmental crises they face. However, they further observed that the responses of the government have not been significant and that women, men, and children thus continue to face problems such as pollution, poor services, human waste pollution, fumes from household fuels, and the consequences of soil erosion and flooding. Akramolmolok and Narjes (2017) evaluated the potential of rural women in protecting the environment in Marzanabad Village, Iran. They affirmed a positive relationship between the social, economic, and cultural rights of women and recognized their environmental awareness and empowerment in environmental protection. Many studies (Shettima 1996; Sachs 1997; Norouzi and Bakhtiari 2009; Rahmani et al. 2010; Chelala 2011; Annabestani et al. 2012, Dowlati and Hemati 2012; Ghanbari et al. 2012; Ahmadvand and Sharifzadeh 2011) have proven that women establish a direct relationship with their environment through their involvement in various environmental activities. They, therefore, earn considerable knowledge about protecting and caring for their environment. However, their roles in such endeavors have not been given sufficient attention. Meanwhile, Kirk and Okazawa-Rey (1998) and Amirnejad and Rafei (2009) disagreed with such results and corroborated that women's involvement in environmental activities are too below average or even very low due to their insufficient knowledge and experience on how to deal with such environmental activities. For instance, Kirk and Okazawa-Rey (1998) asserted that women's environmental activism is an extension of their roles as daughters, wives, and mothers who care for their families and communities. Therefore, determining the various ways on how women actively participate in environmental protection and management is necessary, with the aim of integrating them into an environmental management program, given that our world faces many problems, such as the illegal dumping of solid and hazardous wastes, climate change, and the destruction of biological resources. The present study aims to investigate women's involvement in environmental management with particular reference to Gaza Strip, Palestine.

5.2 Research Method

The study was conducted to investigate the status of women's participation in environment in Gaza Strip, Palestine. Questionnaire was adapted from past studies by Adebayo and Anyanwu (2005) and Wuyep et al. (2014). A simple random sampling technique was employed to select the participants in this study. The targeted respondents were women who participated in environmental activities in Gaza Strip. Out of 95 sets of questionnaire distributed, there were 70 sets of the questionnaires that were completely done and returned which were useable for the findings analysis. The response rate was 74.3%. The data collected through the questionnaire was analyzed using Statistical Package for Social Science (SPSS) version 20.0.

5.3 Results and Analysis

This part discusses the respondents' overall perception of women participation in environment in Gaza Strip. The findings are presented in frequencies and percentages.

5.3.1 Respondents' Background

As shown in Table 5.1, four aspects on the demographic background of the respondents were collected. The aspects included age, marital status, place, and educational level. As findings, the analysis showed that the majority of sample respondents (30%) are aged 50 years and above and followed by respondents (28.6%) who are aged between categories of 30 and 39 years. Concerning the martial status of the participants, the majority of women (54.3%) are married, followed by 12 (17.1%) who were widowed. From the questionnaire survey, it can be seen that the survey covered fair areas in Gaza Strip where 21.4% participations came from living areas such as North, Gaza, mid zone, and Rafah areas. In terms of educational level, most

Table 5.1 Shows the respondents' background

Items	Frequency	Percentage (%)
Age		
Less than 20 years	3	4.3%
20–29 years	13	18.6%
30–39 years	20	28.6%
40–49 years	13	18.6%
50 years and above	21	30%
Marital status		
Single	11	15.7%
Married	38	54.3%
Divorce	9	12.9%
Window	12	17.1%
Place		
North	15	21.4%
Gaza	15	21.4%
Mid zone	15	21.4%
Khan Younis	10	14.3%
Rafah	15	21.4%
Educational level		
Primary school	9	12.9%
Preliminary school	15	21.4%
Secondary school	27	38.6%
University	13	18.6%
No education at all	6	8.6%

participants were secondary school level (38.6%) followed by those from with preliminary school level (18.6%).

5.3.2 Involvement in Environmental Protection Programs

Women are always playing a big role in environmental protection programs at homes and communities. Based on data collected, nearly 63% (62.9%) women reported that they clean their surroundings daily, while only 20% of them do it weekly (see Fig. 5.1). In general, the roles of women who engaged significantly in cleaning the environment are usually sweeping, clearing of drainage, and other activities such as packing refuse, filing ditches, etc. In Nigeria, specifically in Plateau State, Adebayo and Anyanwu (2005) indicated in their study that 79.2% of women are cleaning their surroundings daily in terms of sweeping and other relevant environmental activities. In Iran, Akramolmolok and Narjes (2017) found a positive relationship between the social, economic, and cultural rights of women, recognizing the environmental awareness and empowerment of women in environmental protection.

5.3.3 Involvement in Agricultural and Soil Conservation

As shown in Fig. 5.2, it can be seen that 71.4% of women are involved in agriculture activities in their rural living areas. Several previous studies have inferred that women contribute to agricultural production by producing more than half of all the crops that are grown (FAO 2011). Globally, women do the majority of agricultural work. Throughout the South Asian region, women account for approximately 39% of the agricultural workforce, with some of them working as managers of land and agricultural labor (IFPRI 2008). In the EU, agriculture is the seventh largest sector

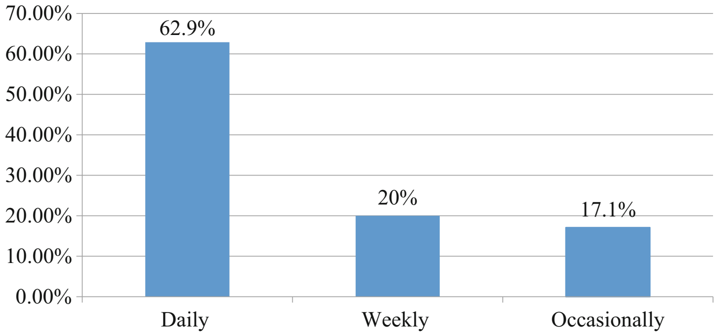

Fig. 5.1 Cleaning of the environment

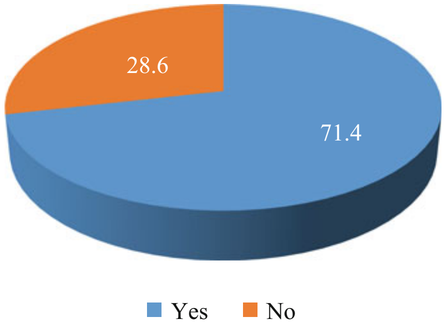

Fig. 5.2 Women activities in managing agriculture and solid conservation

employer of women (3%). In Greece, approximately 38% of women (of all family workers in agriculture) are employed in agriculture. In Portugal, over 50% of the agricultural workforce is female (Wikigender 2008). In Africa, 80% of the agricultural production comes from small farmers, who are mostly rural women (Wikigender 2017). In sub-Saharan Africa and the Caribbean, women produce 80% of basic food stuffs, while, in Asia, women provide 50–90% of the labor force for rice cultivation. Lastly, a total of 60% of women are involved in farming in Adamawa State, Nigeria (Adebayo and Anyanwu 2005).

5.3.4 Involvement in Forest Management and Tree Planting

The results corroborated that women's role in managing forests and tree planting is not that significant, where nearly 95% (58.6%) reported that they do not participate in agricultural activities (Fig. 5.3). The results are in agreement with the finding of Maye (1994) who validated that women propagate seedlings and flowers at nurseries to beautify their environment. The latter finding is also in line with that of Adebayo and Anyanwu (2005) who affirmed that 70% of women in Adamawa State, Nigeria, have planted trees in their compounds in the last 5 years, with 21% of trees having been planted on their farms. Furthermore, Adebayo and Anyanwu (2005) confirmed that 79.2% of the women are involved in farming activities and contribute significantly to land/soil conservation and that 78.4% of them have planted trees or flowers in the last 5 years.

5.3.5 Solid Waste Management

Women play a big role in cleaning the environment and keeping it clean. As shown in Fig. 5.4, it can be found from the obtained results that 75.7% of women participated actively in managing their solid waste. Women play a big role in cleaning the environment especially for managing solid waste and its activities.

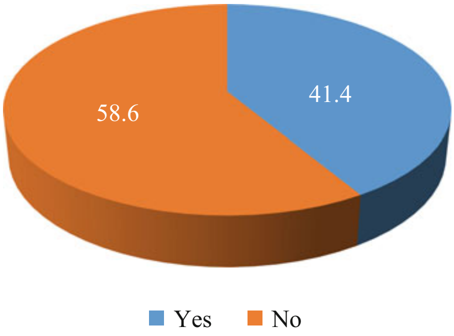

Fig. 5.3 Women involvement in managing forest and planting trees

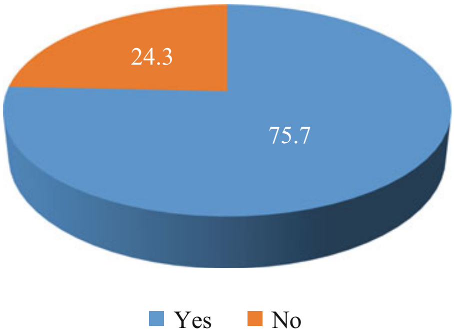

Fig. 5.4 Women involvement in managing solid management

This finding is consistent with those of Adebayo and Anyanwu (2005), Omran et al. (2006), Omran (2008) and Wuyep et al. (2014)) who found that women played a significant role in managing their solid wastes in their living area. Because women are closer to the environment, they engage in environmental management by cleaning the environment and keeping it clean especially in terms of garbage collection and disposal.

5.3.6 Flood and Drainage Management

The analysis did show that only 47.1% of participants reported their involvement in managing flood and drainage in Gaza Strip (refer to Fig. 5.5). In some places, it is common to see people throwing their trash and other things like in the drainage tunnels and sewerage, and this bad attitude of some people made the women to involve and participate actively in keeping drainages around them clean and free from trash, garbage, or any thrown wastes. In Uganda, a study by Kwagala (1999) carried out in Kampala City indicated that drains are mainly cleaned by the women on a regular basis or payed to have them cleaned. Similarly, Adebayo and Anyanwu (2005) reached similar results where they indicated that almost 80% of women in Plateau State, Nigeria, do clearing drainages.

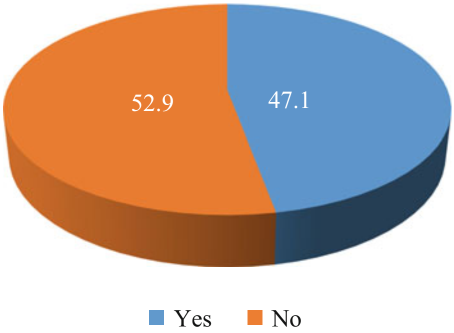

Fig. 5.5 Women involvement in managing flood and drainage

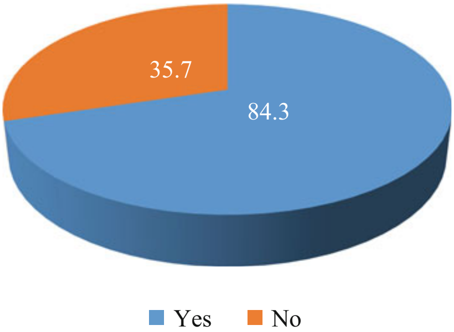

Fig. 5.6 Women involvement in managing water resources

5.3.7 Water Resources Management

The survey affirmed that most of the women (84.3%) play an effective role in managing water resources (Fig. 5.6). Al-Naber and Shatanawi (2004) conducted a study on the role played by women in irrigation management and water resource development in Jordan and reached similar findings. Moreover, Olanrenwaju and Ogunleye (2007) indicated that women provide water for their various domestic activities in their rural living areas and that the search for and transport of water are solely their responsibility. Rural women have to trek several kilometers to procure water for their domestic activities. The mode and habit of obtaining water from the river bank pollute the water.

5.4 Conclusion

As stated by the past studies that women are the best contributors in protecting the natural resources and caring for environmental in Asia, Africa, in some European countries, and also South and North America, it can also prove that the Palestinian women are playing huge roles in practicing some activities to protect the environment, but unfortunately the Palestinian women have not been given proper attention toward their practices with the environmental activities. Such ignorance or neglecting may be affecting the country in the future because these women are expecting many things from the responsible government and authorities to keep their practice and progress positive. It could be concluded from this study that the relationship between women and the environment will remain unique, but it needs worthful addressing from time to time, and in order to encourage and attract women to participate in environmental protection and sustainable development, the government should ensure the following recommendations be considered:

- Allowing and encouraging the Palestinian women to participate at different level including the national, regional, and international levels on environmental issues such as preserving and protecting the nature.
- It should be recommended to give a big opportunity to the women to be involved in decision-making for issues like policies, funding of environment, etc. Perhaps one of the examples to be highlighted here is by giving bank and credit loans in the form of long-term loans with low bank percentage for women activities especially rural women in preserving and reviving programs which increases their motivation.
- Women roles as water resource managers, farmers, and irrigators must be increased to ensure efficiency in managing water resources.
- Educating women particularly on environmental activities and related issues must be set up in a place as priority policy. Such education will allow women to contribute more actively in bridging the gap between environment and development.

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Chapter 6
Water Contamination and Health Hazards in Pakistan: An Overview of the Current Scenario and Contemporary Challenges

Hafiz Waqas Kamran and Abdelnaser Omran

Abstract Drinking water contamination is to be considered as primary health concern in the present world. In developing countries like Pakistan, arsenic in drinking water has threatened more than 60 million individuals especially in the most populated province of Punjab. Present study aims to address this mass poisoning issue which has created severe health diseases in all age categories. An overview of present steps taken by the Government has also been reviewed under this discussion. Besides, some proposed solutions like legislative controls, governance, up to the mark sewerage system, treatment of industrial wastes, and anti-water pollution rules and regulations are also recommended. For the better sustainability of both environment and public health, serious attention is required from the relevant authorities to overcome this burning issue through recommended solutions.

Keywords Water contamination · Arsenic · Punjab · Pakistan

6.1 Introduction

For all the living organisms, water is considered as a fundamental necessity as it is significantly related to health. But increasing various diseases in the human beings and properties of water in the form of physical, chemical, and biological are very much crucial to address (Hanna-Attisha et al. 2016; Shah et al. 2012). In the present time, several toxic materials and their existence in drinking water is a major problem for both developed and developing economies (Ahmed et al. 2013; Nawab et al. 2017). Production activities of various industries have produced harmful wastes which ultimately mixed up with the drinking water and cause a serious problem

H. W. Kamran (✉)
School of Economics, Finance and Banking, College of Banking, Universiti Utara Malaysia, Sintoks, Kedah State, Malaysia
e-mail: hafizwaqaskamran@gmail.com

A. Omran
Faculty of Engineering Sciences, Bright Star University, El-brega, Libya

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(Nawab et al. 2017). From the global context, one-fifth of the population is facing the problem of contamination in the drinking water in the form of feces and more than half million deaths have been recorded worldwide (Singh et al. 2017). However, the situation of water contamination is much worst in developing and poor economies because water supply sources are a major contributor for the mortality and morbidity (Ashbolt 2004; Mosley and Chen 1984; Singh et al. 2017; Wright et al. 2004).

6.2 Overview of Quality of Drinking Water in Pakistan

A country like Pakistan is blessed with the natural resources, but the approach to drinking water is up to a dangerous limit. It is found that only 20% of the population has access to safe and clean drinking water in the country (Daud et al. 2017). The rest of the 75% is forced to drink either fully or partially contaminated water. The massive utilization is the key reason for the poor water supply for domestic, industrial, and agricultural purposes (Daud et al. 2017). Besides, the addition of municipal sewage and waste material and industrial wastewater and lack of decontamination and monitoring of quality at various water plants are also serious challenges. As per the findings of Pakistan National Convervation Strategy (PNCS), 40% of the diseases are because of contaminated drinking water which includes giardiasis, diarrhea, infection, gastroenteritis, and intestinal worms. The condition of infant deaths around the country is 60% which are caused by water-related diarrhea; thus having the highest ratio is the Asian region (Ahmed et al. 2007; Shahid et al. 2015). The risk of contaminated drinking water is the worst in the most populated province of Punjab and after that in other regions (Daud et al. 2017; Khan et al. 2013, 2017). According to the findings of the United Nations International Children's Emergency Fund (UNICEF), almost 20–40% of hospitals in Pakistan have patients who are facing the waterborne illness (UNICEF 2016). Figures 6.1 and 6.2 explain the probability of arsenic level in the different regions of Pakistan. As per the report of WHO (2017–2018), it is noted that the probability of arsenic level with unsafe drinking water is almost 100% in the most populated area of Punjab (Lahore). Such alarming situation of arsenic contamination in drinking water is causing severe health hazards to millions of populations across the country and creating diseases like lung cancer, skin disorder, and heart disease (DAWN 2017).

Due to a microbe in drinking water, toxin issue is also another problem in drinking water. Such contamination is very harmful to both humans and animals and causes disease like liver and kidney problems (Badar et al. 2017). The existence of other heavy metals in drinking water causes a serious health problem with their ubiquitous bioavailability. The contamination issue is not just because of arsenic but similar other metals in surface water, groundwater, and wastewater as expressed by Waseem et al. (2014). They have also claimed that such contamination is damaging the nutrition of vegetables, overall ecological environment, and soil as well. For the high level of arsenic pollution in water, Rasool et al. (2017) have pointed out the anthropogenic activities across the country in different regions. As per the findings of Pakistan Council of Research in Water Resources (PCRWR), it was found that

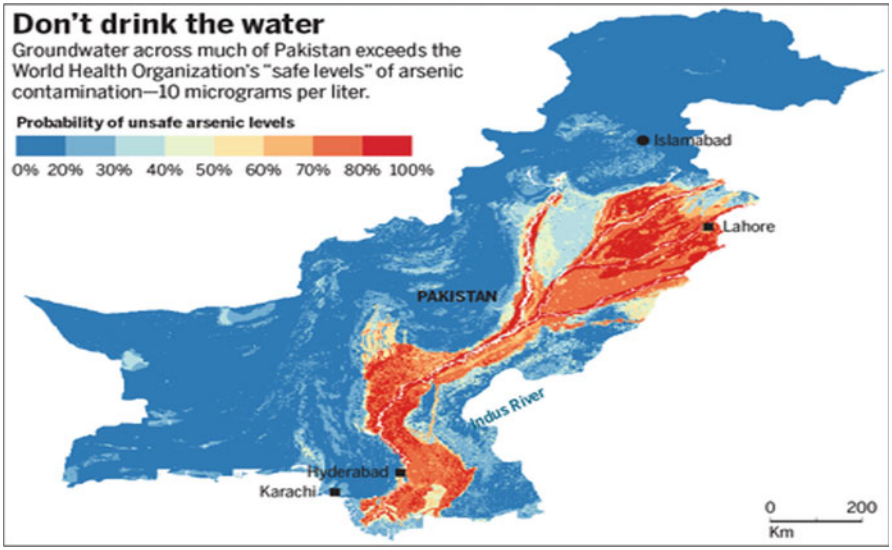

Fig. 6.1 Arsenic in drinking water. (Source: Guglielmi 2017)

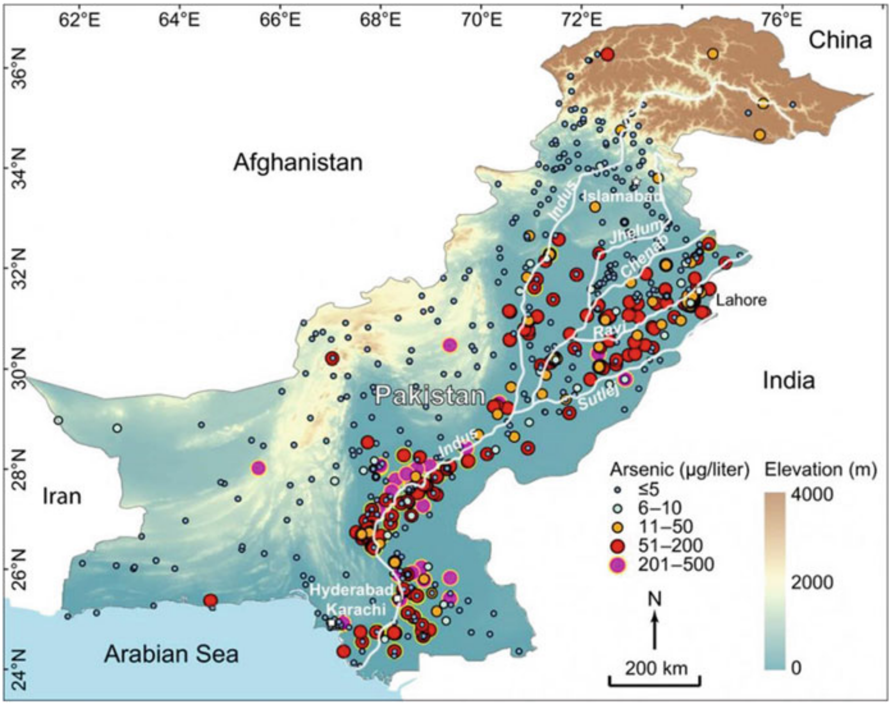

Fig. 6.2 Contaminated water poisoned map (Pakistan) (Podgorski et al. 2017)

majority of the people in the country are relying on the groundwater, unearthed through motor and hand pump. This ratio is 60% in urban and almost 70% in rural areas. The issue of over population in urban areas has increased the demand for the drinking, and most of the habitants are conntected to private water suppliers. A study conducted by Hamid et al. (2013) has examined the performance of WASA in the capital city of Punjab: Lahore. They have examined the physicochemical elements and found that the level of arsenic and fluoride is above the national set standards and WHO limits. In addition, it is found that water lines from some points are mixed with the sewerage lines because of the existence of coliform in the selected sample.

6.3 Steps by the Government to Control Water Contamination

For the last couple of years, Government of Pakistan is trying to develop various strategies to control water pollution in the country; for instance, the introduction of water policy and related mechanism for the usage of all types of water and repair of infrastructure, etc. The plan to develop the water policy at the national level was initially proposed in the year 2015, and point of focus is to protect the drinking water for the citizens (Kiani 2015). In addition, due to this policy, first-time policy makers have realized that water is among the scarce resources and can only cover the specific demand. So, the focus of the policy is to manage the water demand with the control of population growth as well. Besides, under this policy, it is promised that safe and clean drinking water will be provided to the entire population: urban and rural (Kiani 2015).

To control the increasing threat of water contamination in Pakistan, various strategies are available which needs serious attention from the Government. At first, the legislative control provides an overall framework to control this threat. In Pakistan, the Water and Sanitation Agency (WASA) is directly responsible for the quality of water and development of relevant standards. Drinking water standards are established which include key parameters, standard values, World Health Organization (WHO) guidelines, and final remarks. Meanwhile, color of drinking water (<15 TCU/Hazen Units.), taste and odor with turbidity (below 5 NTU), pH (6.5–8.5), chemical parameters for aluminum (less than 0.2 mg/L), antimony (<0.005 mg/L), arsenic ($\leq$ to 0.05 mg/L), barium (proposed to be 0.7 mg/L), and boron (0.3 mg/L) as per WHO guidelines (Ministry of Environment 2008). Although these set standards are very much effective to a gradual improvement, these standards are still missing which show poor management of drinking water by the relevant authorities. For the sustainability of the water, steps are also taken at the provincial level. For instance, in the city of Lahore, a rule has been passed for Sunday not to wash the cars by the individuals to control the water conservation. At recent time, Chief Minister of Punjab has established a program under the title of "Punjab Saaf Pani" and has established 80 water filtration plants in south Punjab by the end of 2017 (Malik 2017). For the control of water waste, both at the domestic and industrial level, the PCRWR has established eight centers in different regions. Each center has its strategic significance with the research and development (R&D) objectives and has research and test laboratories, experimental farms, drainage installation equipment, and groundwater investigation cells. For R&D, a national water quality laboratory (NWQL) is established in the headquarter in Islamabad which is trying to get international accreditation for water quality (PCRWR 2018). NWQL is equipped with the testing of all types of water which include drinking and irrigation. Besides, a network of water quality laboratories has also been established to provide water testing facilities in major cities as well. The establishment of the National Capacity Building Institute (NCBI) for water quality management with the collaboration of the Korean International Cooperation Agency (KOICA) is another significant effort for the improvement of water quality (PCRWR 2018). NCBI has the following objectives:

- To establish a permanent national level setup for the water supply agencies in Pakistan for water quality monitoring
- To train key managers, staff members, engineers, and scientists
- To produce and promote certifications and diplomas for the water quality management

Besides, PCRWR has completed various projects in the last 15 years which are directly or indirectly linked to the water quality and its improvement. Details are shown in Table 6.1.

6.4 Some Approaches to Control the Water Pollution

For the better public health and sustainability of the environment, protecting the drinking water and its different sources like lake, river, and other underground springs is very much significant. Reducing the water illness secures not only the health diseases but also increases the standard of living in the global community. Various steps have been identified which can protect the drinking water from imputed contamination from the harmful metals. Details are as under:

Normally, all types of drinking water either coming from the ground surface or any other source are vulnerable to numerous contaminators. Multiple barrier approach is a very meaningful strategy which contains several steps to control the water contamination. These barriers include the risk prevention barrier (keeping contamination away from entering various drinking water sources), risk management barriers (Safe Drinking Water Act, hiring of trained and skilled operators, and emergency response plan, i.e., disaster management), risk compliance barriers (effectiveness in dealing with safety of drinking water), and finally individual action barrier (consistency in vigilance of drinking water) (EPA 2015).

In addition, various other steps can be considered to protect the groundwater from contamination. The first strategy is the selection of the location which must not be

Table 6.1 Completed development projects (2001–2015)

No.	Name of the project	PC-I cost (Rs. million)	Expenditure cost (Rs. million)	Duration
1.	Safe water provision	1413.35	1002.356	2006–2015
2.	Monitoring of water quality	39.655	39.655	2009–2014
3.	Rainwater harvesting and desertification control in the Kharan-Chagai Desert of Balochistan	37.371	37.371	2006–2014
4.	Combating drought and desertification in the Thar Desert by management of water resources	35.53	35.53	2005–2014
5.	Enhancement and management of ground-water resources in Balochistan	38.68	38.68	2004–2014
6.	Mass awareness for water conservation and development	154.45	113.31	2007–2011
7.	Integrated land and water management studies for agriculture development in Pothwar region	33.9	27.492	2004–2011
8.	Strengthening of WRRC Peshawar for undertaking research in water resources management	37.64	35.302	2004–2011
9.	Water quality monitoring in rural areas of Pakistan and installation of low-cost water conditioning and filtration units	38.71	36.829	2004–2011
10.	Participatory national integrated water management program	177.21	123.75	2004–2011
11.	Improved water conservation practices for NWFP and northern areas of Pakistan	39.9	33.175	2004–2011
12.	Sustainable technologies for efficient water management in irrigated areas of southern Indus plain	38.57	34.351	2004–2011
13.	Mitigation of desertification for poverty alleviation by integrated management of land and water resources in the Cholistan	34.44	34.44	2004–2010
14.	Result-oriented short-term research studies to improve water resources of mountainous areas	28.01	25.747	2004–2010
15.	Integrated development and management of water resources in water-scarce areas	33.48	32.89	2005–2008
16.	Research studies for sustainable management of water resources in the upper Indus plain	24.08	21.219	2005–2008
17.	Arsenic monitoring and mitigation in Pakistan	35.8	35.8	2005–2008
18.	Demarcation of groundwater quality zones in Indus plain and its marginal areas for sustainable development and management of groundwater phase-I (upper Indus plain)	36.515	36.515	2003–2008

(continued)

Table 6.1 (continued)

No.	Name of the project	PC-I cost (Rs. million)	Expenditure cost (Rs. million)	Duration
19.	Strengthening of PCRWR by establishing GIS and hydrologic modeling center and water resources data bank	34.46	34.46	2004–2008
20.	Strengthening of PCRWR regional office, Lahore, for undertaking research on irrigated agriculture	30.739	30.739	2004–2008
21.	Impact assessment of sewerage and industrial effluents on human health, water resources, and agriculture productivity in Faisalabad	7.8	7.8	2004–2007
22.	National water quality monitoring program	39.66	39.66	2002–2007
23.	Upgradation of WRRC Quetta to undertake rejuvenation of depleting aquifers and propagation of high-efficiency irrigation system in Balochistan	38.288	38.288	2001–2006
24.	Mitigation of drought disaster in the Cholistan Desert by management of water resources	152.501	152.501	2001–2006
25.	Upgradation of laboratories and libraries of PCRWR	30.09	30.09	2001–2006
26.	Construction of headquarters building and research laboratories of PCRWR	33.271	33.271	2002–2004

Source: PCRWR (2018)

near to the polluted area before drilling a well or construction of any water supply. In remote areas country like Pakistan, farmers and villagers have significant information about the best cite in their areas for the drinking water and drilling of wells. However, selection of a site for the construction of well or similar water facility in the future should consider the following key points:

- It can provide convenient access to all the inhabitants, throughout the year.
- It should be constructed at the level where it has a minimum level of threat like a seasonal flood or any natural disaster.
- At a reasonable distance from the agriculture land where consistent usage of pesticides is present.
- It is also at a reasonable distance from the dumping or recycling area.

6.5 Recommendations for the Treatment of Contaminated Water

The following are the key recommendations for the Government and various administrative staff members who are directly or indirectly involved in dealing with the quality of drinking water. These are:

1. In housing societies across the country, installation of monitoring plants is very much necessary which will treat the polluted water in a significant way.
2. Replacement of old and leaking water and sewerage pipes needs serious attention in different areas, especially in Punjab province.
3. To evaluate the overall water system, assessment through microbial technique can be a significant tool.
4. The improved drainage system is very much required across the country in most of the remote areas, this is among the major issues causing water pollution.
5. Development of long-term water management plan by the Government authorities regarding abstraction, discharge, supply, and finally the protection of existing water resources.
6. Appropriate distribution of drinking water source across the country with the application of regulatory compliance and their proposed impact on the overall environment.
7. Priority should be given to preserving the sources of drinking water and its demand through contingency plans.
8. For the federal level water management policy, integration with the provinces and with the neighboring countries should be the first strategy to be developed.
9. Water authorities should make sure that the set of standards are followed by the society and the industry in the country.
10. Integration of managerial, technical, and financial measures for the management of wastewater through treatment plant should be under regular surveillance for smooth working.

6.6 Conclusion

The present study has reviewed the overall scenario of water pollution in the region of Pakistan. Among the key issues, arsenic contamination in the drinking water specifically in the Punjab province has been highlighted with significant findings. Based on the stated facts, it is found that sustainability of drinking water in Pakistan is at a dangerous level and the Government and relevant authorities require some serious steps. A review is also conducted for overall performance by numerous departments, responsible for the quality of drinking water with the projects completed during the time of 2001–2015. Millions of investments is done by the Government of Pakistan to sustain the water quality, but still not enough due to various challenges like managerial, technical, financial, and demographic as well. However, to control the increasing threat of unsafe drinking water, immediate protective measures and treatment technologies are the need of time.

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Chapter 7
Water Security: Challenges to the Irrigation Water-Energy Nexus in Australia

Stefanie Schulte, Georgina Davis, and Jennifer Brown

Abstract Energy and water are inextricably connected in agricultural systems, and with a changing climate and growing population, the water-energy-food nexus is creating wicked problems at multiple scale. Over the past decade, Australia's irrigated agricultural sector has responded to pressures of water resource scarcity, climate variability and productivity challenges by making large-scale structural adjustments on farm. Converting existing on-farm irrigation equipment has achieved significant water savings; however, there have been unintended consequences associated with these structural adjustments, including higher electricity costs. Escalating electricity costs have negatively impacted Australian agricultures' profitability and productivity and encouraged food and fibre producers to irrigate at inefficient times or revert towards more water-intensive practices. Several agricultural producers have also considered switching to alternative energy supply options or a return to 'dryland' farming. The case studies presented in this chapter focus on Queensland and New South Wales, showcasing the challenges of Australia's agricultural producers in reconciling their water and energy requirements whilst producing high-quality food and fibre. The case studies illustrate how uncoordinated State and Federal Government policies are undermining sustainable agricultural practices in Australia and impacting the broader environment. The authors also outline how agricultural producers are progressively tackling the water-energy-food nexus challenges through innovative thinking and collaborative engagement between different stakeholders. There are signs that Australia is at the point of addressing complex problems such as the water-energy-climate change nexus. Hence, policymakers should heed this signal and apply the emerging concept of the modular principle to tame what currently remains as a wicked problem, the water-energy-food nexus.

S. Schulte
New South Wales Irrigators Council, Sydney, NSW, Australia

G. Davis (✉)
Queensland Farmers' Federation, Brisbane, QLD, Australia

Australian Rivers Institute, Griffith University, Brisbane, QLD, Australia
e-mail: g.davis@griffith.edu.au

J. Brown
Cotton Australia, Sydney, NSW, Australia

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7.1 Background

The term 'nexus' refers to a connection or a connected group or series. The water-energy-food nexus is an increasingly used approach to frame the challenges associated with integrating human development objectives with the responsible management of natural resources (Johnson and Karlberg 2017). The water-energy-food nexus is also being recognised as a 'wicked policy problem' – that is, resistant to resolution due to its complex and interconnected nature (Rittel and Webber 1973). Globally, the collective challenges from a growing world population and increasing climate uncertainty will require a paradigm shift in understanding how water, energy and food are interconnected, how their interdependence can be quantified and how this knowledge could assist in policy and regulatory decision-making processes (WEF Nexus Research Group 2018). Australia, like other developed economies, struggles to adequately integrate sustainable water and energy management and regulation, often leading to perverse and conflicting policy outcomes for Australia's agricultural producers who are the single largest group of land owners in the country. In 2016–2017, 393.8 million hectares of land was owned or operated by 88,073 agricultural businesses in Australia (ABS 2018a). Almost half of Australia's total land area (340,763,119 ha of a national total of 769,202,000 ha) is therefore used for agriculture and of all the States and territories. Despite the significant proportion of Australia's landmass dedicated to agriculture, decisions concerning commodity/crop type are highly dependent on factors including, but not limited to, climatic conditions; future water availability; access to water trading arrangements; electricity tariff (price) options; global commodity prices; fluctuations of various input costs; rotational cropping driven by soil health; rising groundwater; and other environmental considerations. Out of necessity and in response to external economic and regulatory drivers, agricultural producers in both Queensland (QLD) and New South Wales (NSW) are becoming increasingly flexible in their commodity/crop decisions adapting to increasing fluctuations in these factors.

As the global population rises towards the predicted 9.8 billion by 2050 (United Nations 2017), there are increasing demands on, and opportunities for, QLD's and NSW' agricultural sectors. An increasing global population is driving unprecedented demand for high-quality food, fibre and other high-value products including bioproducts (including biofuels and biochemicals). QLD and NSW are uniquely located in their proximity to Asian markets and are developing new transport and logistic infrastructure to expedite fresh product delivery to growing, often high-end markets. Both QLD's and NSW' agricultural sectors are heavily export-orientated (including beef cattle, sugar, cotton, pulses), with QLD contributing approximately AUD$14,013 million (crop generated being AUD$6721 m) and NSW approximately AUD$14,500 million (crop generated being AUD$8397 million) in

2016–2017 (ABS 2018b). Whilst it is unrealistic for Australia to be the 'food bowl of Asia', Australian food exports do provide sufficient calorific intake for 61,536,975 people, based on current average daily calorific intake of people in Asia (Australian Farm Institute 2017). Whilst Australia is an exporter of agricultural commodities, many of these markets have been established on premium 'Australian-branded' produce for quality assurance and traceability (Woodhead et al. 2015), particularly high value-added protein foods, fresh fruit and vegetables through to increasingly niche products, such as guinea fowl.

7.2 On-Farm Productivity Trends

By attempting to meet the increasing demand for high-quality food and fibre in the Asia-Pacific region, Australia is subject to significant external competition and major institutional impediments. In contrast to most of the world's wealthy industrialised countries who have sought to protect their agricultural producers from competition by imposing high import tariffs, import quotas and direct price support mechanisms, Australia has withdrawn many direct producer payment support mechanisms. This was done with the belief that it would act as a mechanism to drive on-farm innovation and reduce economy-wide costs. The level of agricultural producer support in Australia is currently the second lowest in the OECD area at under 3% of gross farm receipts (ABARES 2014). However, this approach, at face value, appears to fundamentally contradict the Australian agricultural sector's declining productivity. Between 1948–1949 and 2013–2014, the 'total factor productivity' (TFP) grew at an average of 2% per annum, driven by technological advances and innovation (ABARES 2015). During this period, there has also been a reallocation of resources from inefficient farms to those with higher efficiencies. This has driven productivity growth in Australian agriculture and led to more than two-thirds of the growth in agricultural output during the post-war era (Mullen 2010). However, over the past 20 years, agricultural TFP has fallen, from 2.6% a year, between 1948 and 2000, to 0.9% since the late 1990s (ABARES 2015). Most concerning, TFP declined at −0.2% for the period between 1999–2000 and 2009–2010 (ABARES 2015). The productivity slowdown (and decline) is considered to have been heavily influenced by the Millennium Drought (1996–2010), coupled with declining public investment in agricultural research and development (Sheng et al. 2010).

Productivity growth is essential to maintaining the competitiveness of Australian agricultural producers in global markets as well as to offsetting negative impacts to on-farm profit factors, such as rising input costs. Broadly, the sector is confronted with high production costs (energy, water, labour), excessive regulation, high currency exchange and natural resource pressures associated with climate change. Additionally, for some sectors (namely, animal welfare), increasingly multifaceted 'social licence to operate' conditions have led to a reduction in intensity (e.g. the transition to free-range eggs and poultry). The agricultural sector also continues to struggle with fluctuating commodity prices; and rising competition from countries with extensive producer-support packages and the intensity of this competition is escalating (Keogh 2011).

Agriculture and sustainable agricultural productivity are essential for the long-term welfare and economic security of rural QLD and NSW. It also provides increased food (nutrient) security, both domestically and within the Asia-Pacific area. Yet, Australia's agricultural sector is showing indications of decreasing capacity and faltering productivity gains, threatening the resilience of some rural businesses. Surveying of rural agricultural businesses by the Climate Council (2016) has shown that many businesses have drawn down on their financial reserves and, in many cases, have taken on increased debt in response to extreme weather events. As Australia's climate becomes more variable and there are more extreme weather events, adaptation (and cost) to those agricultural enterprises will become increasingly challenging. The ability for many agricultural businesses to dedicate funds for practical and enduring on-farm resilience measures, such as technology or infrastructure, is being diminished by unsustainable input costs, most notably the price of grid-supplied electricity. Research (Kiem et al. 2010; Kiem and Austin 2013) into the indebtedness of farming enterprises (food and fibre) has highlighted the financial unsustainability, acknowledging the impacts from rising input costs and the trends in poor profitability over the past decade. This has been coupled with limited number of options other than debt to finance farming activities (McGovern 2014; Moshin 2015). The Climate Council (2017) refers to climate change as a 'threat multiplier' in terms of its ability to exacerbate existing stresses on rural businesses and communities as well as adding new ones. Both QLD and NSW agricultural producers are now having to manage legacies, such as salinity which has arisen from historical poor farming management practices (e.g. in the Burdekin region), new land use challenges such as their co-existence with the new coal seam gas (CSG) industry, a legacy set of abandoned mines and resulting contamination issues. However, there are also a range of emerging issues that both QLD and NSW agricultural producers must adapt to. These include increasing regulatory burdens in water, energy and natural resource management. Additionally, there have been rising costs which have resulted from uncoordinated and often contradicting State and Federal policy development. The following sections provide a regulatory and policy overview of the two input factors, water and energy (particularly electricity), that are influencing and often constraining agricultural producers in QLD and NSW against the backdrop of going climate change risk.

7.2.1 Climate Change: QLD and NSW

Within the water-energy-food nexus, climate change is increasingly impacting the QLD and NSW agricultural sectors, not only on its own but through the increasing interlinkage between agricultural input costs (namely, electricity and water) and the regulatory and policy settings associated with natural resource planning and food production. Both QLD and NSW benefit from a varied range of climatic zones and microclimates. These facilitate a wide diversity of growing conditions and the ability, in some areas, to provide multiple cropping opportunities within a single year. As such, agricultural production is distributed geographically and across different climatic zones. Much of the most productive arable land in QLD is located in the south-east areas or closer to the coast, whilst western parts of the State are dry and drought prone and more widely utilised for grazing purposes. In contrast, NSW' most productive and diverse arable land is located in the south; however, some areas in central and northern regions (like the Liverpool Plains) are considered some of the most fertile agricultural land in the State. In terms of climate, northern QLD is affected by the seasonal migration of the monsoon across the equator. This results in a distinct dry season (May to September) and wet season (October to April), with the latter part of the wet season characterised by monsoonal activity. The south-eastern QLD region is characterised by a range of climates from subtropical in the north through to temperate in the south, with a typically drier winter and wetter summer. This area is also influenced by large-scale atmospheric circulation drivers, particularly the El Niño Southern Oscillation, leading to high variability and the occurrence of droughts and floods (CSIRO 2012). On the eastern Australian coast (QLD and down into NSW), the formation of 'East Coast Lows' can also have a significant impact on water resources, resulting in intermittent large inflows into water catchments. This area has also been subject to considerable climate variability, including the Millennium Drought and the two wettest years on record for Australia (2010–2011) as a result of two strong La Niña events (CSIRO 2012). QLD is the most natural-disaster-prone State in Australia (ABS 2012a; Davis 2016). With an increasingly variable climate, impacts to agriculture will manifest, particularly in the frequency and intensity of extreme weather events. These will range from longer dryer periods, intense flooding, fewer frosts and warmer temperatures for longer and increased maximums (WWF 2015).

Temperatures in Australia were relatively stable from 1910 to 1950. Since then, both minimum and maximum temperatures have shown an increasing trend, with an overall increase from 1910 to 2010 of approximately 0.8 °C (ABS 2012a). Australia has warmed by approximately 1° since 1910. The warming has occurred mostly since 1950, and the frequency of daily temperature extremes has also changed since 1910 (Bureau of Meteorology 2017). The number of weather stations recording very warm night-time temperatures and the frequency with which these occur has increased since the mid-1970s. The rate of very hot daytime temperatures has also been growing since the 1990s (Bureau of Meteorology 2017). According to the fourth biennial State of the Climate report (CSIRO 2016), the duration, frequency and intensity of extreme heat events have increased across large parts of Australia, causing extreme fire danger and heat waves in many parts of the continent. Further, there has been a decline of approximately 11% in April to October growing season rainfall in the continental south-east since the mid-1990s (CSIRO 2016). Given the changes in climate and the associated alteration to Australia's rainfall patterns and temperatures, many areas are becoming dryer and, in many cases, also warmer, which in turn decreases agricultural water from run-off, surface water availability and groundwater recharge. With the lower water availability, there have also been decreases in dam and on-farm storage levels. Australia is committed to domestic and international actions on climate change (Paris Agreement) and is implementing national policies to reduce emissions and adapt to the impacts of climate change (Australian Government 2018). The Paris Agreement aims to strengthen the global response to the threat of climate change by ensuring global temperature rise this century is below 2 °C above pre-industrial levels (UNFCCC 2015). For Australia, its rapidly changing climate is already impacting agricultural producers in both QLD and NSW through prolonged dry periods, unseasonable hot temperatures and unpredictable (and often low) rainfall pattern. Further, uncoordinated policy development and conflicting regulation that often does not consider or incorporate climate change provide additional challenges for food and fibre producers in both States.

7.3 Nexus Regulatory Frameworks

7.3.1 Integration vs. Separation

Like other developed economies, Australia not only struggles with the impact of climate change but also lacks an integrated water-energy-food regulatory and policy framework. Water resources are managed separately to energy and food production at both Federal and State level, thereby creating contradicting policy directives that are often leading to inefficient and costly operational outcomes for food and fibre producers in both QLD and NSW. The lack of an integrated nexus framework is easily observable on a national level, where ‘water resources’ are managed jointly with agriculture but not with ‘energy’ (Australian Government 2018a). Instead, ‘energy’ is jointly managed with ‘environmental matters’, including climate change. A different separation of portfolio responsibilities exists on a State level (NSW) where ‘water resources’ are managed together with ‘industry and lands’ (NSW Department of Industry 2018a) as well as the ‘environment and heritage’ (NSW OEH 2018), whilst ‘energy’ is managed jointly with ‘resources’ and ‘planning’ (NSW DPE 2018a). The absence of an integrated approach to the water-energy-food nexus on both the Federal and State level has challenged Australian agricultural producers who are caught between competing policy objectives and numerous regulatory responsibilities.

7.4 National Water Resource Regulation

The regulation and management of water resources has been a contentious issue in Australia since pre-federation times. When the six separate self-governing colonies of QLD, NSW, Victoria, Tasmania, South Australia and Western Australia united to form the Commonwealth of Australia, there was considerable debate as to which powers should be vested in the Federal Government and which powers should remain with the States. After extensive negotiations, it was decided that the States should retain control over the administration, management and allocation of water resources within their respective State boundaries. The explicit legislative powers of the Federal Government were codified in section 51 of the Australian Constitution (Australian Government 2018e) and consisted of only those issues that affected the whole of the nation, including trade and commerce, taxation, defence, corporations and external affairs (Parliament of Australia 2018a). Water resources were not explicitly listed in section 51 of the Australian Constitution and hence lay outside the direct legislative powers of the Federal Parliament. Nonetheless, the Federal Government has, in conjunction with the State Governments of NSW, Victoria and South Australia, carried out aspects of water resource management in the Murray-Darling Basin since the early 1900s through intergovernmental agreements and interjurisdictional bodies like the River Murray Commission and subsequently the Murray-Darling Basin Commission (MDBA 2015).

As water resources remained the remit of the respective State Government, approaches to water management, administration and governance varied widely between States, driven by the distinct characteristics of river basins and the administrative structures of State Governments (Bureau of Meteorology 2018), as well as differences in definitional and regulatory approaches. From the beginning of the 1990s, significant water resource management reforms were initiated in response to the Federal Government's national competition policy reform (COAG National Competition Council 2018a). As part of these broader reforms, a national strategic framework for water was developed by the Council of Australian Government (COAG National Competition Council 2018b). This framework and subsequent intergovernmental agreements set high-level, long-term national visions for water resource management and governance and provided the States with guidelines around new market-based reforms that were aimed at achieving efficient and sustainable water use (COAG National Competition Council 2018b). Despite these overarching principles and guides, State Governments retained discretion around how to implement the broad-based water reforms, leading to diverse approaches to water management, water governance and water administration (Holley and Sinclair 2016). The reforms that commenced in the 1990s eventually morphed into a hybrid governance system that was based on 'top-down' regulation and 'bottom-up' catchment planning linked together through detailed stakeholder consultation. Additionally, a 'decentralised' cap-and-trade market-based regime developed following the separation of land and water rights and the introduction of an interim cap on surface water extraction in 1995 (Murray-Darling Basin Commission 2004). The latter two initiatives (the cap on extraction and the separation of land and water rights) were of particular importance to prevent further growth in water extraction in the Murray-Darling Basin and establish a functioning water market valued at approximately AUD$612 million (entitlement trade, 2016–2017) or $AUD58 million (commercial allocation trade, 2016–2017; AITHER 2017). However, the COAG water reforms of the 1990s were frequently at risk through constitutional conflicts between the Federal and State Governments whereby State Governments were unwilling to support the national water reform agenda (Kelly 2007). As a result, the Federal Government imposed 'accountability measures' on the States, including financial incentives for the successful implementation of key reform goals (Holley and

Sinclair 2016). Although progress was made throughout the 1990s, prolonged drought conditions throughout the 2000s further threatened the water reform efforts. Consequently, the then Australian Prime Minister John Howard put water on the national agenda for the 2004 Federal election and subsequently signed the 2004 National Water Initiative (NWI) (Australian Government 2017). The NWI consolidated the early 1990s' reforms and extended the 'cap-and-trade' market-based systems; removed barriers to trade; facilitated efficient water use; and amended previous water accounting frameworks. Under the NWI, State and Federal Governments committed to increasing the efficiency of Australia's water resources through (among other things) the preparation of comprehensive water management plans (discussed further in Sect. 2.2.1). In response to ongoing drought conditions, the Federal Government eventually took a more active role in the management of water resources in the Murray-Darling Basin when the then Prime Minister John Howard introduced the National Plan for Water Security in 2007, followed by the *Water Act 2007 (Cth)* and the *Basin Plan 2012 (Cth)* (Parliament of Australia 2018b). This active role of the Federal Government was only possible through the Federal Government's use of its 'external affairs' powers under section 51 of the Australian Constitution. Sections 3.1 and 4 provide a detailed overview and analysis of the recent Federal water reform process and the interaction between the Federal Government's water reform process and the water-energy-food nexus.

7.4.1 State Water Regulation: QLD and NSW

Based on the Intergovernmental Agreement on a National Water Initiative (COAG 2004), the State Governments developed state-based water management regulation and planning instruments. In NSW, the key legislative instrument for the management of water resources is the *Water Management Act 2000 (NSW)* (WMA). The Act provides the statutory framework for managing water resources in NSW and is built on the principles that sustainable and integrated management of the State's water resources should be for the benefit of both present and future generations (NSW Department of Industry 2018b). The *WMA* also recognised the need to provide water to the environment (as a legitimate water user) and establish a more secure access to water for existing water rights/entitlement holders (NSW Department of Industry 2018b). The main regulatory tool to manage water resources in NSW is Water Sharing Plans (WSPs) (NSW Department of Industry 2018c). Since the commencement of the WMA, over 80 WSPs have been progressively developed, covering NSW. WSPs set out the rules for sharing water between 'consumptive' water users and 'the environment' as well as establish water access provisions for different types of water licence holders (e.g. domestic supply, stock watering, industry, town water supply, the environment) (NSW Department of Industry 2018c). Enshrined within these WSP provisions is a clear hierarchy for how water resources are allocated in NSW. Firstly, the State Government is required to meet the needs of the environment and humans before any water is allocated to industrial or agricultural users for the purpose of any commercial activity (NSW Department of Industry 2018d). This means that in times of severe drought, agricultural producers may not receive a water allocation (such a scenario occurred during Australia's Millennium drought 1995–2010), creating additional constraints for food and fibre producers who have to meet ongoing fixed costs of their business. Also, the WSPs provide for the allocation of water for commercial purposes (including agriculture) in accordance with specific licence classes (e.g. these licence classes were developed following the introduction of the NWI and the State's separation of water rights from land titles, thereby creating quasi-property rights to water) (NSW Department of Industry 2018d). In an average year, licence holders receive progressive allocations according to their licence classes which generally start low and increase over the water year (1 July–30 June) as inflows become more certain. However, in any given year, water allocations can vary between 0% and 100% of the water licence entitlement share. In NSW, water licences consist of a share component that is issued in perpetuity and an allocation that is made against this share every season (NSW Department of Industry 2018e). Both the entitlement share and the allocation can be traded, so that ownership, control and use can change over time. Individual water licence holders can therefore use their allocation, trade it to other licence holders or transfer it intertemporally (e.g. carry-over) (NSW Department of Industry 2018f). Carry-over provisions are not available to all licence categories, and the volume permissible to carry over is not uniform across NSW (NSW Department of Industry 2018f). The difference is due to different catchment conditions and access to available storage space. This divergence in individual WSP is mirrored in other State-based water regulation and planning instruments, including QLD.

QLD has enshrined its NWI obligations into the *Water Act 2000 (QLD)* and has developed 24 water planning areas (Department of Natural Resources and Mines 2017). Water Plans for these areas provide a legal 'head of power' as they are subordinate legislation and apply to surface water and, in some areas, groundwater. Similar to NSW, the adoption of approaches in each Plan varies depending on local circumstances. These include expected climate change impacts, the level of development of the water resource and the type of water supply system (e.g. groundwater or surface water, connected or non-connected system). QLD's climate variability means that it is difficult to identify how water resources may be affected over the timeframe and scale of a Water Plan and, as such, Water Plans are able to respond to a range of intra-annual and inter-annual variations. The QLD and NSW Governments use a range of hydrological and climate modelling that incorporates historical climate variability and future projections (where relevant) to determine sustainable water use and to inform water entitlements and have incorporated adaptive approaches to manage water resources. The natural expiry (every 10 years) of the Plans then permits for any readjustments to water entitlements from climate change to be made whilst providing a period of certainty to the agricultural water user. The science collected over the life of the Water Plan is essential information for evaluating the effectiveness of implementation and whether a plan is achieving its outcomes.

This legislation also provides a framework for a trade-off between environmental flows and consumptive water. Changes in water resource availability may require reconsideration of water made available for human uses and that set aside for the environment. For example, if water availability declines due to climate change, the relative allocation of water for consumptive versus environmental use will reflect a complex mix of allocation rules which are contained within QLD's legislation and also the Water Plans themselves. In QLD, there are requirements so that water for human needs and minimum environmental flow conditions are met before allocation of water for general use, including for agriculture. Given the water management principles and the hierarchy of water allocation in both NSW and QLD, agricultural producers are often challenged by the complex State water management regulation that constrains their access to water. With ongoing climate change risk and the fact that agricultural producers are often 'last in line' for any water allocation creates a necessity to undertake detailed planning and risk management to remain financially viable and productive. In addition to the constraints imposed by State-based water management regulation, there are further limitations imposed on agricultural water use through the Federal Government water reform process.

7.5 National Electricity Regulation

In parallel to the developments in water management regulation, significant changes occurred in the regulation of the electricity generation, transmission, distribution and retail functions in the 1990s. Also, similarly to water, legislative powers concerning electricity/energy reside with the States due to constitutional arrangements. Prior to the National Competition Policy reform of the 1990s, Australia's electricity market consisted mostly of vertically integrated utility monopolies which were owned and operated by the respective State governments (Crossley 2013). The National Competition Policy reform process ignited a broadscale restructure of the Australian electricity market, including the separation of generation, transmission, distribution and retail functions as well as a change to the regulatory structure governing the electricity market. The main objective was to achieve greater market competition, increased efficiency and transparency in order to improve the long-term interest of consumers (Government of South Australia 1996). The National Electricity Market (NEM) is the single largest electricity market in Australia, operating in QLD, NSW, Australian Capital Territory, Victoria, South Australia and Tasmania (AEMO 2018). The NEM is governed by the Australian Energy Market Agreement (2004) (COAG Energy Council 2003) which is the national framework for the management and supply of energy (both gas and electricity) in all Australian jurisdictions; however, to date the active participants in the NEM remain the eastern States and Tasmania.

With the National Competition Policy reform of the 1990s and the move towards more market-based approach to regulation, the NEM is considered an 'unbundled' electricity market with competition (be it limited) among generators and electricity retailers. The transmission and distribution network service providers (TNSP and

DNSP, respectively) in each State act as natural monopoly business and sole providers in their respective supply areas. The TNSP and DNSP are either State-owned or operated by private network providers and are independently regulated by Australia's national energy regulator, the Australian Energy Regulator (AER), to mitigate potential monopolistic competition behaviour (COAG Energy Council 2018a).

The regulatory framework of the NEM is set out in the National Electricity Law (NEL) and associated the National Electricity Rules (NER) as well as the National Energy Retail Law (NERL). These are administered by participatory States and territories via application acts which have been passed by the respective State and Territory Parliaments to give effect to the extent to which the NEL and NERL apply in the respective jurisdiction (AEMC 2018a). The resulting framework established 'shared ministerial oversight of national energy policy and law through a ministerial Council [currently known as 'Council of Australian Government (COAG) Energy Council'], chaired by the Australian Government's Energy Minister' (COAG Energy Council 2018b), and the three key bodies responsible for the governance of the NEM. The Australian Energy Market Operator (AEMO) supervises wholesale generation within the NEM, whilst the Australian Energy Regulator (AER) regulates the TNSP and DNSP. The Australian Energy Market Commission (AEMC) reviews and amends the NER in response to rule change proposals. Outside this core regulatory framework is the COAG Energy Council which is made up of State and Federal energy ministers who pursue national energy policy reforms (AEMC 2018b). Despite the previous unbundling of the Australian electricity market, the structure and regulatory framework governing Australia's electricity market still resembles the requirements of previously large-scale centralised generation, transmission and distribution of fossil fuel energy sources (Crossley 2014). This feature of the NEM poses challenges for the economic regulation of the prevalent monopoly businesses (ACCC 2018) but also barriers for the integration of new technologies which are able to operate across the traditionally defined boundaries of the unbundled Australian electricity market (e.g. energy storage system) and renewable energy generation assets. For example, solar, wind and biomass assets are able to be owned and operated by private landholders who may have the capabilities not only to fulfil their own energy needs but indeed act as an energy provider to the national electricity grid. To date, around 80% of Australia's electricity supply (equating to approximately 200 TWh annually) is provided through the NEM, thereby making it one of the world's largest interconnected electricity power systems with 40,000 km of transmission lines and nine million customers (AEMO 2018a).

The NEM's framework is built on a model of large-scale synchronous energy generation, a vertically integrated transmission and distribution network and competing retailers, where electricity prices are settled via spot prices and risks are hedged via complex financial contracts (Australian Government Department of the Environment and Energy 2018c). Yet, recent technological advances in renewable energy generation and energy storage assets, in addition to energy market reforms spurred by the 2012 *Power of Choice* review, have created additional challenges and complexities to the existing structure of the NEM (AEMC 2018c). For example, a large number of nonsynchronous variable renewable electricity generators, wind and solar (Finkel Review 2017), have come online in recent years – totalling 4644 MW across QLD and NSW (QLD Government 2018; NSW DPE 2018b) – as a result of decreased capital costs. This nonsynchronous variable generation has not only added an increasing number of decentralised energy generation to the NEM, but the vertically integrated grid is not well equipped to handle the rapid change. In addition, new products, processes and business models have come to the market – from the generation of electricity through to its end use (Finkel Review 2017) – that consumers are looking to satisfy their energy needs.

Finally, there is a distinct political dimension of the COAG Energy Council and member jurisdictions setting their own priorities concerning sources of electricity and greenhouse emissions or low carbon. For example, in response to climate change, the Australian Government has committed to reduce its greenhouse gas emissions by 26–28% below 2005 levels by 2030 under the 2015 Paris Agreement (Australian Government 2015). NSW has a net emission target of zero by 2050 and prior to this had developed a 'Renewable Energy Action Plan' which referenced a previous Federal target of 20% renewables by 2020. QLD on the other hand has a 50% renewable target by 2030. Some years prior to this commitment, States and territories had set for themselves renewable energy targets (RET) and/or emissions reductions targets. This has itself created an unstable and complicated policy environment (COAG Energy Council 2018a, b, c) where increasingly decisions are being deferred by governments at all levels to the COAG Energy Council. It has also provided impetus for the Australian Government to investigate the creation of a National Energy Guarantee (NEG), designed to address the energy 'trilemma' of secure, affordable and low-carbon energy. The solution to the energy trilemma is however difficult due to the size of the current electricity network and the lack of coordination around the integration of renewable energy generation assets into the existing grid. There is also the conflict of interest that arises as the State Governments remain the majority shareholder of the previously vertically integrated distribution and transmission networks in regional Australia. Incentives to change the operation of the grid are distorted as the State Governments derive a significant amount of revenue from the ownership of these assets (ACCC 2018).

7.6 Energy and Water Use in Agriculture

Agricultural producers in QLD and NSW are challenged by a complex web of State and Federal water and energy regulation that is often driven by competing policy objectives. As a result, agricultural producers find themselves squeezed between tightly controlled water management regimes and an outdated and overregulated national energy market system that is plagued by conflict of interest and driven by capital investments that continuously drives further price increases. Challenges arise due to the rigidity of Australia's water and energy regulation that is unable to address the heterogeneity of Australia's agricultural producers. Across NSW and QLD, there

Table 7.1 Heterogeneity of irrigation equipment (Sapere Research Group 2018)

Irrigation equipment	Use (%)
Microsystem pipe network	36
Pivot irrigators	15
Winch irrigator	22
Other	26

are numerous agricultural businesses who grow a large variety of crops (at various scales), deploy different irrigation methods and utilise various equipment to produce food and fibre (NSW DPI 2018a). For example, water delivery to crops can occur via one or two stages, from a water source to storage and from source/storage to the crop. This may require further 'on-farm' pumping for one or both stages. Agricultural methods are also diverse. Some growers apply surface water irrigation (e.g. flood or furrow) where water is distributed by gravity, whilst others have installed sprinkler systems where high-pressure water is sprayed over larger land surfaces (Table 7.1). Alternatively, a pipe network above or below ground can often deliver irrigation water (e.g. including drip or microspray). Correlated with this diversity in agricultural methods is a wide variety of irrigation equipment that is deployed (Sapere Research Group 2018).

Agricultural producers access a wide range of water sources which have their own unique challenges (such as water access restrictions, salt intrusion, subsidence). For example, irrigators in QLD and NSW may have access to surface water (either directly or via irrigation schemes) and/or groundwater (depending on their water licence). Also, both surface water and groundwater may be part of larger (hydrologically) connected systems (e.g. the southern connected system) or be completely disconnected, e.g. either hydrologically or through the classification of the water source in the respective water management regulation (MDBA 2018a). Under what circumstances food and fibre producers are able to access water depends on a range of factors. These include seasonal water availability, respective state legislation and water management and planning instruments as well as any other interstate commitments. Once a water allocation announcement is made, licence holders generally have the opportunity to 'use', 'trade' or 'carry-over' (depending on the circumstances) all or part of their allocation. For those larger interconnected surface water (and groundwater) systems, trade of water allocations or water licences is generally available which can be an effective approach to managing climate risk (ACCC 2016). Groundwater systems, whether large or small, require additional considerations for groundwater-dependent ecosystems and to ensure the groundwater resources receive adequate recharge. In regions where a drying climate is expected, planning for a reduction in water extraction may be required. Table 7.2 illustrates the water use by Australian agriculture by State or territory and the range of sources from that agricultural producers' access water. QLD has the second largest number of irrigated agricultural businesses in Australia and is the second largest user of water in agriculture. And whilst QLD is the largest user of recycled/recaptured water, it is also the largest user of groundwater resources. In contrast, NSW has the third largest number of irrigated agricultural businesses and is the largest overall user of water in Australia.

Table 7.2 Water use on Australian farms for the year ending 30 June 2016 (ABS 2017)

	Aust.	NSW	VIC	QLD	SA	WA	Tas.	NT	ACT	MDB[a]
Agricultural water use										
Agricultural businesses ('000)	85.7	26.1	20.8	18.2	9.5	8.4	2.3	0.4	0.0	35.5
Agricultural businesses irrigating ('000)	22.7	5.3	6.0	5.4	3.1	1.5	1.2	0.2	0.0	9.2
Total water use ('000 ML)[b]	9157.3	2805.3	2095.0	2646.1	858.8	372.6	332.1	47.0	0.3	5209.9
Water applied for irrigation ('000 ML)[c]	8381.4	2610.9	1946.1	2433.5	777.8	287.5	308.7	16.9	0.1	4938.4
Water applied for other agricultural purposes ('000 ML)[d]	775.9	194.5	148.8	212.6	81.0	85.1	23.5	30.1	0.3	271.6
Change in total water use from 2014 to 2015 (percent)	−2.5	−15.5	−10.2	11.3	15.8	16.7	36.6	−21.9	32.5	−12.6
Sources of agricultural water										
Irrigation channels or pipelines ('000 ML)	3096.2	965.7	1067.7	789.2	117.9	101.2	53.2	1.3	0.0	2087.6
On-farm dams or tanks ('000 ML)	980.1	228.6	103.1	410.5	20.1	87.6	126.4	3.6	0.2	438.5
Rivers, creeks or lakes ('000 ML)	2412.5	885.2	540.0	610.1	231.4	14.1	124.0	7.5	0.1	1656.4
Groundwater ('000 ML)	2357.2	675.5	292.3	761.7	432.3	141.6	19.3	34.4	0.0	926.2
Recycled/reused from off-farm ('000 ML)	161.0	23.3	49.9	57.3	11.3	15.6	3.6	0.0	0.0	56.2
Town or country reticulated mains supply ('000 ML)	126.5	21.3	37.5	8.8	43.6	11.8	3.4	0.1	0.0	35.6
Other water sources ('000 ML)	23.8	5.7	4.5	8.4	2.2	0.7	2.2	0.0	0.0	9.5

[a]Murray-Darling Basin (MDB)
[b]Includes water applied for irrigation and other agricultural purposes
[c]Includes water applied to pastures and crops
[d]Includes livestock drinking water, dairy or piggery cleaning, etc.

Total water use however does not provide a complete picture of the challenges and trade-offs around water access for individual licence holders (e.g. either imposed via State and Federal water legislation or the costs associated with accessing the water). For example, whilst groundwater usually provides for greater reliability than surface water, access to groundwater via pumping is often significantly costlier than utilising surface water due to greater energy requirements. Studies have found that the (electricity) cost impacts are particularly severe on agricultural producers who have pumped or pressurised systems due to the electricity intensity of their irrigation equipment (Sapere Research Group 2018). As such, agricultural producers who have invested in water efficient systems often find those (water) efficiency savings more than consumed by increased power bills. The total costs of accessing a megalitre (ML) of water depends on (a) the State-based water licence and usage charges; (b) farm set-up and the water delivery system (e.g. on-farm and off-farm); (c) the load profile of the irrigation equipment and the associated State-based electricity tariffs (or diesel costs); and (d) the water requirements of the planted crop. Whilst the farm set-up and the water delivery system are generally fixed, points (a), (c) and (d) can vary within and between seasons due to differences in water access and the determination of tariffs/rates associated with water and electricity/diesel. In particular, various studies have demonstrated the pumping regimes are dictated by crop water requirements and licencing arrangements which in turn constrain the timeframe in which irrigation can occur (Sapere Research Group 2018). This often results in inelastic demand by agricultural producers who are not able to vary their energy and water use – making them vulnerable to inflexible tariff arrangements. Despite this inelastic demand, agricultural (electricity) load generally have lower costs to supply compared to 'typical' small customer loads due to seasonal demand peaks in late spring (QLD) and early summer (elsewhere) corresponding with rainfall variations between regions. Approximately 45% of irrigation loads operate continuously throughout the day; however, those that irrigate for part of the day have pump loads predominantly overnight and at a minimum during the afternoon (at the time of system peaks). Most critically, very few pump loads are 'on' at times of peak system demand, suggesting that agricultural producers do not substantially contribute to temporal congestion within the NEM (Sapere Research Group 2018).

However, given the current electricity tariff framework, agricultural producers are often faced with 'demand/capacity' electricity tariffs (e.g. including demand charges) that apply in NSW and QLD when consumption of electricity exceeds 160 MWh, irrespective of the demand on the network (AER 2015). Due to the nature of the farm set up and water delivery system (e.g. pumps and pressurised systems), this threshold is nearly always exceeded during irrigation periods in both States although the quantity of electricity consumed may be low. Whilst both QLD and NSW growers had access to specific agricultural/irrigation tariffs (NSW) or transitional tariffs (QLD) in the past, both States have progressively phased out these specific irrigation tariffs since the 2014 (Sapere Research Group 2017). In the case of QLD, transitional tariffs are the due to expire in 2020 (QCA 2017). With this shift, agricultural producers have been progressively moved to 'demand/capacity' electricity tariffs that have caused an exponential cost increase without a corresponding increase in electricity use. This is because demand/capacity tariffs do not correlate with the volume of electricity used but with the load placed on the network. The tariff developments and the corresponding cost increases have raised serious questions as to the financial viability of agricultural producers, and many have considered going off-grid or reverting to more water-intensive irrigation practices. Whilst both steps are problematic, the latter is more worrisome in the context of ever-increasing water scarcity in a climate change context plus the increasing demand on and costs of water. In addition, substantial electricity network augmentation has occurred since 2009 which has raised questions as to whether the transition to demand/capacity tariffs was appropriate. Demand/capacity tariffs are considered suitable if there are 'constraints' in the system (e.g. in the delivery of electricity). However, given the large-scale infrastructure upgrades to the QLD and NSW networks, network constraints only exist in small isolated pockets across both States (most of which are located close to major population centres like Brisbane and Sydney) (Grant 2016). Whilst this factor would support further tariff reform, governments across the NEM are disincentivised to change the current tariff structure as a large number of residential consumers (with small loads) have benefited from the change at the expense of users with larger loads, including agricultural producers (AEMC 2014). Given the cycle of revenue determinations for QLD and NSW distribution network services, this is likely to cause distributional cost issues, as agricultural producers are charged for large loads over short time periods (despite the lack of constraints in the network).

7.7 The Murray-Darling Basin Plan and Its Direct Relationship with the Nexus

The Murray-Darling Basin (MDB) covers 14% of Australia's land area across QLD, NSW, Victoria, South Australia and the Australian Capital Territory. The geography of the Basin takes in 23 rivers and their catchments. Almost four million people inside and outside the Basin need its water for the survival of their families, communities and industries. Around 70% of Australia's irrigation occurs within the Basin, accounting for 40% of Australia's agricultural produce (MDBA 2014). The MDB is a diverse and dynamic system. Its characteristics are constantly changing in response to the influences of people, the climate and the way available water is used for agricultural production and other industrial use, by communities (including for cultural values of Australia's indigenous people) and the environment. Water availability is an increasingly important issue within and outside the Murray-Darling Basin, and the Millennium Drought (1995–2010) magnified the concerns about future water availability for both consumptive and environmental use. For that reason, the then Prime Minister John Howard introduced the National Plan for Water Security in 2007 which fundamentally altered the landscape of water management and regulation in the Murray-Darling Basin. The National Plan for Water Security not only created a direct role for the Federal Government to manage water resources in the Basin, but it also comprised of a ten-point Plan (the Plan) to improve water efficiency on- and off-farm as well as address overuse of water in the Murray-Darling Basin (Parliament of Australia 2018b). The corresponding legislative instruments relevant to achieve these objectives were the *Water Act 2007 (Cth)* and the *Basin Plan 2012 (Cth)*. Whilst the Act provided the broad parameters of the water reform process and established several new Federal agencies (including the Murray-Darling Basin Authority and the Commonwealth Environmental Water Holder) that were tasked with developing, monitoring, managing and reviewing the water reform process and the Commonwealth's water entitlement portfolio, the Basin Plan established quantitative targets for reduction in water use. The Plan specified that the basin-wide baseline diversion limit (BDL) was 13,623 GL (reference year 2009) and a corresponding sustainable diversion limit (SDL) should be 10,873 GL (MDBA 2018). The SDL is defined as the maximum long-term annual average quantities of water that can be taken on a sustainable basin from Basin water resources in a particular SDL resource unit (e.g. to protect and restore valuable ecosystems). As the SDL was set below the BDL, long-term average water use had to be reduced by 2750 GL (MDBA 2018). To achieve this reduction, the Federal Government recovered water entitlement 'from willing sellers' via direct water entitlement purchases or infrastructure funding to improve water efficiency in exchange for water entitlements (Australian Government 2018b). For QLD and NSW, the impacts of these buy-backs have been mixed. However, direct entitlement purchases have generally led to greater social and economic impacts in irrigation-dependent communities due to lower agricultural production, lower employment and hence reduced economic activities (MDBA 2017). These irrigation-dependent rural communities in QLD and NSW are heavily reliant on the MDB for (irrigation and domestic and stock) water (Gell and Reid 2014) and to adjust to previous operational, technological and market changes which have increased demographic and social pressures. These communities are also experiencing other challenges, such as exponential increases in the cost of electricity which flow through as losses of essential local welfare services. As such, community vulnerability to further water buy-backs, either willing or mandatory, is high. Peak advocacy groups (QLD Farmers Federation 2017) have called for the need for communities to be appropriately informed and equipped with the right tools and assistance to be adaptive and resilient to these changes. They have also called for the adoption of non-flow, complementary measures into the assessment procedure to meet the 'sustainable development limit' and improve overall environmental conditions which include the control of pest species such as carp which reduce water quality or through to cold-water pollution mitigation through the installation of thermal curtains on major headwater storages. More work must be done by the QLD, NSW and Australian Government to understand the environmental improvements and water equivalence of these non-flow measures. Particularly where the future of the buy-back of water entitlements from 'willing sellers' is in doubt with many of the willing sellers now removed from the market. In these cases, prime agricultural land has been taken out of production. Farm businesses are also now buying water to simply 'give back' later so that they can assure their future existence. These perverse, negative outcomes are unsustainable. Irrespective of the methods of water recovery, the *Water Act 2007 (Cth)* and the *Basin Plan 2012* have impacted agricultural producers as they have reduced in the 'productive water' entitlement pool, e.g. 2117.5 GL; June 2018 (Australian Government, Department of Agriculture and Water Resources 2018b), which will not be available for food and fibre production in the Murray-Darling Basin in the future. Further, as early water recovery processes focus on nonstrategic entitlement purchases, the impact of the Federal water reform process has been magnified as the transfer of water from agricultural production to the environment has not been accompanied by an associated productivity gain. The latter infrastructure funding program has consistently ignored broader policy developments, including energy generation and food production. For example, the infrastructure investments for on-farm and off-farm irrigation equipment have led to an increasing electrification in irrigated agriculture and changes in land use practices. Despite achievements in water efficiency, the exponential increase in electricity costs since 2009 (ACCC 2018) has threatened the financial viability of the previously installed water efficient infrastructure and has impacted productivity in the agricultural sector. Without a coordinated holistic State and Federal Government approach to integrated resource management which reconciles water efficiency and energy intensity in agriculture, Australia's food and fibre production will be at significant risk. Peak advocacy groups have called for Australia's next wholesale water reform process (Australian Parliament 2017), with a comprehensive assessment on whether the current institutional and regulatory reforms have achieved the overarching objectives of the National Water Initiative and the National Plan for Water Security whilst accounting for developments in other natural resource policy areas (e.g. energy and food production) are still outstanding. Given the ongoing power struggle between the Federal Government and the Basin States, it remains to be seen whether Australia's existing institutional, regulatory and governance arrangements are robust and durable enough to reconcile ongoing water, energy and food challenges. Particularly, the full implementation of the Basin Plan 2012 continues to be politically and practically challenging given the Basin States' responsibility for water and the interjurisdictional conflict between Basin States. The Basin Plan also addresses the issue of current and future climate change through some of its water sharing mechanisms (Reisinger et al. 2014). Climate change is predicted to decrease water availability in the Basin, posing a risk to rural communities and the environment. Also impacted are agricultural businesses which rely on the water for food and fibre production; they have built businesses and irrigation infrastructure and water delivery systems on the predictions of future water availability (Reisinger et al. 2014). Agricultural production within the Basin has been reduced and will be further reduced if the climate change predictions (which predict a substantial 'drying') are realised, despite comprehensive adaptation (Garnaut 2008; Qureshi et al. 2013). The additional challenge of climate change makes it ever more important to address the regulatory and policy challenge identified in Australia's water-energy-food nexus context.

7.8 Case Studies

7.8.1 Lack of Integrated Policy Development in NSW and the Nexus

NSW water and energy regulatory and governance framework is rooted in the National Competition Policy Reform which was premised on the idea that competitive markets would best serve the interest of consumers and the wider community. However, the QLD and NSW Governments have since lacked the capacity and willingness to effectively integrate and harmonise the water-energy-food policy areas within and across State borders. This lack of coordinated and integrated policy development has particularly affected food and fibre producers due to significant energy and water infrastructure investments in NSW. This has caused significant electricity price increases at the same time as irrigated agriculture has become more energy intensive. Whilst water is a prerequisite for all food and fibre production, energy has become an increasingly important input factor in agriculture. This is due to continuous water scarcity concerns and water conservationist policy measures that were initiated following the commencement of Australia's Millennium Drought in late 1995. Not only was access to water for agriculture significantly curtailed following the 1995 Murray-Darling Basin Ministerial Council agreement to place a 'cap' on surface water diversion (Murray-Darling Basin Commission 2004), but further NSW and Federal water reform processes (see above) have reduced the pool of available water. This has been through the introduction of Water Sharing Plans and large-scale water entitlement recovery efforts by the Federal Government under the *Water Act 2007 (Cth)* and the *Murray-Darling Basin Plan 2012 (Cth).* As a consequence of the increasing risk of future water scarcity and the transfer of water licences from agriculture to the environment, the opportunity to access water for food and fibre production is diminished. As such, agricultural producers have considered other measures and structural adjustments to remain financially viable and productive. In particular, under the *Basin Plan 2012 (Cth)* and in response to predicted ongoing water scarcity across the Murray-Darling Basin, the Australian Government increased its focus on improving water management in the basin. It did so by investing significantly in long-term initiatives designed to better balance the water needs of communities, agricultural producers and the environment. This occurred primarily through the AUD$12.9 billion Water for the Future initiative (Australian Government 2008). Whilst this initiative contained a suite of urban and rural policies and programmes, including funding for water purchases, irrigation modernization, desalination, recycling and storm water capture, AUD$5.8 billion was allocated against the Sustainable Rural Water Use and Infrastructure Program (SRWUIP) (Australian Government 2012). The SRWUIP is thereby the largest component of the Water for the Future initiative and incorporates programmes such as the NSW Private Irrigation Infrastructure Operators Program and the On-Farm Irrigation Efficiency Program (OEFIEP) in the southern connected system, e.g. Murray and Murrumbidgee valley and the Lower Darling (Australian

Government 2012). A total of 1538 subprojects have been funded by the Australian Government to improve the efficiency of on-farm irrigation system and nonfarm water use through measures (Australian Government 2018d) such as (a) installing new or upgrading irrigation infrastructure or technology through automated water management systems and sensing equipment; (b) improving irrigated area layout or design for the purpose of improving on-farm irrigation efficiency; (c) upgrading of/conversion to surface and sub-surface drip systems and overhead spray systems such as lateral move or centre pivots; and (d) ancillary equipment necessary for new or upgraded irrigation system to function. All projects that have been approved under OEFIEP (Rounds 1–5) have provided the Australian Government with 152.6 GL (calculated as long-term average annual yield) of water savings to 'bridge the gap' towards the sustainable diversion limit under the *Basin Plan 2012 (Cth)*. Although the achieved water savings have been significant, many on-farm infrastructure upgrades under SRWUIP have come at the cost of higher energy use (e.g. via new pumped or pressurised irrigation systems). Coinciding with the increasing electrification in agriculture came a large increase in electricity costs, mainly driven by large-scale infrastructure investment for electricity distribution network businesses. According to the AER, NEM-wide network investment over the 2009–2014 regulatory cycle was over AUD$7 billion for transmission networks and AUD$36 billion for distribution networks (AER 2013), with the largest investment occurring in QLD and NSW. The large-scale infrastructure investment translated into significant cost increases for agricultural producers in NSW who are serviced by the Essential Energy. An internal industry analysis in 2014 revealed that electricity bills for irrigators had increased by up to 300% over the period, 2009–2014 (NSWIC 2014). This additional cost pressure was also confirmed by the Australian Competition and Consumer Commission in a 2017 inquiry into retail electricity pricing which concluded that 'network costs were proportionally more significant in QLD and NSW than other States' and 'network revenue increased the most in QLD and NSW, peaking respectively at 200 percent (in 2015) and 190 percent (in 2013) relative to 2006 revenue' (ACCC 2017). Furthermore, the Energy Security Board's first Health of the National Electricity Market report (December 2017) declared that the 'National Electricity Market (NEM) is not in the best of health' and the three immediate symptoms are (1) electricity bills are not affordable; (2) reliability risks in the system are increasing; and (3) future carbon emission policy is uncertain (COAG Energy Council 2017). The Energy Security Board noted that the retail electricity prices have increased by about 80–90% (AUD$, real) over the last decade, making affordability (of electricity) a major concern (COAG Energy Council 2017). Whilst both electricity and water infrastructure upgrades were driven by State and Federal policy directives, the lack of coordination between the two meant that Australian food and fibre producers were caught between the two competing policies of 'energy security' and 'water security' which were difficult to reconcile. Whilst water efficiency measures were driving energy intensity in agriculture, energy security measures were driving up prices of electricity which undermined previous water efficiency upgrades in agriculture. To address these competing policy initiatives, agriculture sought the assistance of the State Government (NSW Office of

Environment and Heritage) to undertake a pump efficiency pilot project to assess the energy productivity of on-farm irrigation equipment in rural areas. The pump efficiency pilot consistent of 11 large irrigation businesses and an irrigation infrastructure operator in regional areas and was conducted over a period of 18 months (NSW OEH 2017). Following extensive on-farm and off-farm assessment of the existing pumping equipment, the pilot found that many irrigation pumps were '(un) fit for purpose, had discharge heights that were too high, suffered from valve and suction entry issues and had issues with belts and pump cavitation' (NSW OEH 2017). Each of these issues caused higher than necessary electricity costs for the irrigation businesses. Overall, the pilot estimated that through small-scale adjustments to the existing irrigation equipment and electricity tariff adjustments, pilot participants would be able to save between AUD$31,000 and AUD$314,000 in their overall electricity costs (NSW OEH 2017). In terms of individual results, one of the case studies highlighted the significant benefits from the installation of power factor correction units on pumping equipment. An irrigated cotton producer in northern NSW who used both diesel and electricity to operate his irrigation pumps and on-farm infrastructure had a yearly electricity consumption of around 2700 MWh, and diesel consumption is approximately 173,000 GJ. Several irrigation pumps were running on electricity and were billed on 'obsolete' network tariffs. Due to a recent change in the National Electricity Rules (NER), the cotton grower was moved to new 'demand-based tariffs' (AEMC 2014) causing the grower to incur an additional AUD$100,000 in costs to operate his four irrigation pumps. However, the pump efficiency audit found that if the grower installs power factor correction units at all pump sites, there is a reduction in maximum demand, saving over AUD$50,000 per annum under the new tariff structure arrangements (NSW OEH 2017). A second case study showcased how the use of off-peak periods and an optimised use of the on-farm irrigation equipment could reduce overall costs for the growers. A family farm in central NSW grew wheat and cotton on approximately 900 ha (212 ha under pivot irrigation). The property's yearly electricity consumption was approximately 1400 MWh, and the yearly diesel consumption is 7300 GJ. One of the river pumps was run on electricity. Comparing the usage profile over 12 months, it was determined that if the pump could be run at 85 kW constantly, it would avoid being captured under demand-based tariffs. Hence, if the grower ran the pump during 'off-peak' times (except during heavy irrigation use periods such as January and October), they would be able to save approximately AUD$12,000 a year (NSW OEH 2017). One of the pumps in the second case study drew water directly from the main irrigation supply channel. This process delivered water to six pivots that irrigated the northern part of the property. Up to three pivots could be supplied at any one time. The flow rate delivered by the pump was determined by the number of pivots operating and was controlled by the line pressure at the pump. The line pressure was a fixed value based on the pressure required to run three pivots. Usually not all three pivots were operating at the same time. The audits showed that if the grower was able to run three pivots instead of two, changing the irrigation patterns across farm, they would be able to save an additional AUD$12,000 a year. If only one pivot was run, the cost would be about AUD$50,000 greater than if three pivots are run. Changes to pivot use would hence achieve optimum pump/motor efficiencies (NSW OEH 2017). Whilst the pump efficiency pilot was able to illustrate that energy efficiency upgrades were beneficial and could reduce overall electricity costs for agricultural producers, they were also difficult to implement due to various regulatory, operational and cost constraints (mainly in water regulation). Further, the pump efficiency pilot also showed that there is rarely a 'one size fits all' solution but required tailored solutions that suited the individual irrigation businesses. Despite the cost savings achieved through the pump efficiency pilot, it became apparent that this initiative was not enough to mitigate rising electricity network costs. Consequentially, the agricultural industry has commissioned further work to assist food and fibre producers to address the electricity cost pressures and find more sustainable long-term energy solutions for the industry.

7.8.2 Basin Plan Implementation in QLD and the Nexus

The Commonwealth Government is permitted to buy-back a maximum of 118 GL in QLD. Under this maximum level or cap, the Australian Government also prioritised water infrastructure programmes to assist in the delivery of the water recovery targets. This was done through the 'Healthy Headwater' program in QLD, which provided farm subsidies to upgrade irrigation infrastructure, with irrigators contributing at least 10% of the cost as well as at least 50% of the water savings (by permanent transfer of water allocation) to the Australian Government for environmental use. To date, more than 80 QLD projects are being progressed, representing a water saving of over 46 GL and government funding of more than AUD$110 million to irrigators. An opportunity for improving water use efficiency of irrigation is to replace gravity-fed irrigation systems, such as furrow or border strip, with more efficient pressurised systems (Jackson et al. 2010). The Healthy Headwater program was established to increase water efficiency of on-farm irrigation through the substitution of gravity-fed systems to pressurised irrigation methods. It is now recognised that many of the high-pressure, water-efficient irrigation equipment uses much more electricity than the former, often flood-irrigation methods. However, the associated impact from these 80 projects on energy use (electricity) on farm is not considered as it falls outside the scope of the program. Optimising one aspect of the irrigation process, without due consideration of all other inputs and productivity factors, has resulted in unintended resource and environmental outcomes. Utilising less water on-farm may also not equate to water savings across the Basin (Perry et al. 2009; Molden et al. 2010).

Irrigation is the largest consumer of energy (electricity and diesel) on QLD's farms (QLD Farmers' Federation 2017; Davis and Chamberlin 2016). The energy required for pumping (water) depends on crop requirements (which rise during periods of dry, hot weather), pump type, size and efficiency; and for groundwater, on the total dynamic head (height that a fluid is to be pumped, taking into account friction losses in the pipe) and distance to in-field application.

Studies which have investigated the impacts of the transition from flood irrigation to pressurised systems within the Murray-Darling Basin (Jackson et al. 2010, 2011) have determined that whilst there was a reduction of between 10% and 66% in the amount of water applied on farm, energy consumption increased by up to 163%. The highest energy increases were seen in surface water systems, whereas energy efficiencies could be achieved from groundwater application noting that 'where groundwater is used for irrigation, converting to pressurised micro-irrigation systems can decrease energy consumption if the conversion means that the operating pressures and pumping volumes are reduced' (Jackson et al. 2010). Energy savings are possible when converting from gravity-fed systems to pressurised irrigation methods in groundwater areas, as there is a reduction in the volume of water being pumped (Jackson et al. 2010). However, Jackson et al. (2010) also note that excess water applied from gravity-fed irrigation methods, which was not consumed by the crop/plant and is subject to reuse and subject to geological conditions, will likely drain to shallow aquifers or back to surface waters. The recharge effects of gravity irrigation schemes are not taken into account, and there has not been any qualification of the consumed and nonconsumed fraction in the MDB.

Flood irrigation techniques are also an adopted strategy for managing groundwaters, particularly in areas of rising saline groundwaters. For example, in the late 1970s, QLD's Burdekin region saw the finalisation of a surface water irrigation channel scheme. With additional water supplies more readily available, the Lower Burdekin saw a dramatic increase in surface water irrigation in the late 1980s which led to increased groundwater recharge and rising groundwater tables with some parts of the of the Lower Burdekin experiencing a rise in groundwater levels of up to 10 m over the last 20 years. This has resulted in groundwater levels at less than 3 m below the ground surface across approximately 15% of the irrigated area within the project area. The situation is more acute in some areas where the groundwater table has been measured at only 0.5 m below the surface (QLD Government 2017). High water tables can result in water logging of the soil profile and can also mobilise salts from the underlying bedrock which can increase salinity levels. These factors can reduce the productivity of agricultural land and limit opportunities for future development. High groundwater levels can also lead to higher rates of property and catchment run-off flowing into downstream receiving environments.

7.9 Discussion

Whilst agricultural producers are intimately familiar with the interconnectedness between energy, water and food production, policy and regulatory developments in Australia continue to treat these three areas distinctly separate. This is highlighted by the often deliberate separation of government departments and policy responsibilities. The lack of integration and coordination of water-energy-food policies paired with the continuous restructuring of government departments and the frequent loss of corporate knowledge (driven by regular election cycles) add further complexity to an already challenging operating environment. For agricultural producers this means being continually confronted by competing and often conflicting policy objectives. As the authors discussed in the case studies of this chapter, agricultural producers are facing a multitude of 'natural' challenges, including climate change, above-average temperatures, extended dry periods (including prolonged droughts) and lower water availability (Khan et al. 2006). Whilst many are adjusting their on-farm practices, others are asking themselves whether to plant at all.

Since the development of Australia's water market, options exist for Australian agricultural producers to trade parts or all of their water entitlements/shares as well as allocations. This allows the agricultural producer to recoup some of their on-farm fixed costs during years where they do not produce a crop (or downscale on production). Whether or not the fundamental market structure or the rules governing water trade could be improved to assist agricultural producers to more effectively engage in trading has not been fully answered. However, the authors are of the view that the topic warrants further investigation, particularly in the context of State-based water allocation regimes, the operations of State-owned water storages and the rules governing river operations. On the other hand, once agricultural producers have committed to a crop, the burden of ever-increasing input costs – including electricity – weigh heavily on food and fibre producers who often see their profit margins diminished by expedited policy changes (e.g. climate change policy) and regulatory adjustments (e.g. electricity tariff changes). As the recent water reform under the *Water Act 2007 (Cth)* and *Basin Plan 2012 (Cth)* has highlighted, well-intended water efficiency programmes (e.g. upgrades in irrigation equipment to reduce water use dependency) are being undermined by parallel regulatory changes in the electricity sector. These have exponentially increased the cost of operating the newly installed on-farm water efficient irrigation equipment. Without deliberate action to resolve the 'water efficiency' and 'energy intensity' trade-off in Australian agriculture, the likelihood of perverse and wasteful outcomes will increase. Already, food and fibre producers are actively considering the removal of their previously installed water efficient irrigation equipment to avoid further electricity cost increases. Others are contemplating to switch from electricity to diesel as an alternative energy source. Both developments are deeply concerning; particularly if they are evaluated in the context of climate change and future water scarcity. However, there is a distinct lack of alternative options available to agricultural producers to overcome these multitudes of challenges. Whilst recent technological advances in renewable energy generation, energy storage systems and automation show promising results, the fear of further policy reversals leads agricultural producers to often be cautious about making further large-scale and costly changes on farm. Consequently, the agricultural sector is vulnerable to both 'natural' risk (e.g. climate change, temperature changes, water availability) and 'man-made' risks arising from conflicting policy development that, at times, appear 'resistant to resolution' (Briggs 2007). In this sense, the water-energy-food nexus resembles a 'wicked problem' (Rittel and Webber 1973) at multiple scales. If policymakers are committed to solving complex water-energy-food challenges for Australian agriculture, there needs to be further discussions as to how enduring, long-term coordinated and holistic policies, regulatory frameworks and institutions can be developed. Also, it needs to be ensured that these are designed to endure political election cycles and have a practical, achievable long-term goal. However, there are many elements and layers to the water-energy-food nexus. Instead of devising one 'global' solution, consideration should be given to a more 'modular' approach that is able to develop suitable solutions to the various 'wicked problems' that arise in the water-energy-food nexus (as per the case studies). Such a modular approach needs to build acceptance and consensus among multiple stakeholders and competing interests which itself is premised on the ability to 'hear' and 'be heard'. Engagement and a good understanding of the problems and how they are perceived by various stakeholders are important to devise appropriate solutions that are 'scalable' and can be replicated in different contexts. As the energy sector has highlighted, united calls from the agricultural and business sector to both State and Federal Governments to take action on the 'energy trilemma' (affordability, reliability and low emission) can initiate change. However, a long road is ahead of us to fully integrate the water-energy-food nexus. A few positive steps are observable, yet further leadership is required at all levels of government to bring energy, water and food challenges to the same table. In a time of climate change, time is of the essence. If Australia's policies on water-energy-food are to deliver, it is time to address the nexus challenges and focus on tangible, long-term solutions for Australian agricultural producers.

7.10 Conclusions

Framing a water-energy-climate change 'nexus' for QLD's and NSW' agricultural sectors allows for the identification of critical interlinkages between natural resource management and factors such as agricultural productivity and provides an opportunity to identify the implications from uncoordinated decision-making or government programmes. Domestic policy settings are critical determinants of agricultural productivity as they shape farmers' incentives and capacity to innovate and improve productivity. The imperative of a strong, sustainable and resilient agricultural sector is essential to provide social and economic value to Australia's rural areas and provide food security. As such, there must be State-/economy-wide agricultural policy settings which create conditions conducive to innovation to ensure an efficient and effective agricultural sector.

There is the perception that the cause-effect relations are complex in the water-energy-climate nexus for Australia's agriculture. This is compounded by the lack of clarity around the solutions whilst the magnitude of the issues (at farm level) escalates. Despite these problems being urgent, there is no central authority to solve them, and, indeed, neither State nor Federal Governments assume responsibility. Undeniably, those who have tried to solve them and the government-funded packages supporting these efforts, as outlined in the case studies in this chapter, have, to date, even contributed to their causation and severity. So, what is the best way to effectively address the wicked problems impacting QLD's and NSW' farmers in this time of unprecedented climate change? It has been argued that finding a single solution to climate change or the water-energy nexus is too difficult because it is impossible to get multiple parties with diverging interests to reach a consensus. This has been demonstrated through a lack of a joined-up and adoption of a seamless regulatory approach across Australia and even between neighbouring States with shared water basins. Many of the government-led programmes have been clunky, leading to unintended consequences. The authors of this chapter believe that consensus is essential and that more nimble approaches are needed which focus on smaller-scale independent projects with attainable and measurable objectives. It is essential that they provide value (economic, social, environmental) to every farm. Whilst small-scale projects with achievable objectives may not solve the entirety of the wicked problem outlined in this chapter, they do achieve tangible positive outcomes on farm, aligned with longer-term goals. Such an approach may also foster greater adaptation and innovation approaches which can be readily communicated through the farming community. The issue for governments at all levels is how can such small-scale and on-farm benefits add up to a larger-scale sustainable (agricultural) solution and how does this demonstrate their achievement to national and international obligations such as the Paris Agreement.

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Chapter 8
Sustaining Queensland's Agricultural Sector: Challenges and Opportunities from the Bioeconomy and the Circular Economy

Georgina Davis

Abstract Queensland's agricultural sector is under increasing pressure to provide food to growing populations as well as 'feeding' new fibre, fuel and foliage markets. However, the sector is currently facing major challenges, including climatic factors, soil degradation and increasing social scrutiny, but despite these challenges, Queensland's agricultural sector is growing. It is also seeing diversification across commodities, in particular a move to high-value products and also technological innovation to meet demand for bioproducts and biofuels. Soil is a precious, non-renewable resource. Soil health and soil management, along with the availability of water, largely determine the level of food production. Healthier soils mean healthier food and more prosperous communities. However, soil can be lost forever as a result of intense rainfall when left unprotected or unsupported by appropriate land management practices. Queensland's agricultural sector has an established history of managing its waste streams effectively, ranging from innovative value-added products on-farm to combat food waste to organics and nutrient recycling and also bioenergy production. The return of valuable nutrients back to soil as part of a holistic and effective resource management strategy is essential. However, with increasing demand for bio-resources, will Queensland's agricultural soils lose out to higher-value bioeconomy applications? This chapter discusses the importance of agricultural soils in Queensland and some specific challenges and outlines the risks and opportunities from the state's emerging bioeconomy industry and returning nutrients to soil as part of a circular economy approach.

Keywords Queensland · Agriculture · Bioeconomy · Challenges · Opportunities

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G. Davis (✉)
Queensland Farmers' Federation, Brisbane, QLD, Australia

Australian Rivers Institute, Griffith University, Brisbane, QLD, Australia
e-mail: g.davis@griffith.edu.au

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8.1 Introduction

Queensland is the north-eastern Australian state, covering nearly 1.8 million square kilometres (Queensland Government 2017a), nearly one-quarter of the total land area of the Australian continent and making it the second largest state. The present population is 4.925 million (Queensland Government 2017b) which is expected to increase to between 8.01 and 11.275 million by 2061 (Queensland Government 2015). Agricultural businesses operated across just over half (51%) of Australia's total land area during 2016–2017. On 30 June 2017, there were 394 million hectares of agricultural land in Australia, a six (6) percent increase on the previous year. Queensland's agricultural industries are comprised of:

- Plant industries, including field crops (sugarcane, cotton, grains and pulses), production horticulture (nuts, fruit and vegetables), lifestyle horticulture (turf, flowers, nursery and landscaping) and forestry
- Animal industries, including livestock and livestock products (including cattle, sheep and pigs, poultry, kangaroos and fish/aquaculture) and livestock products, such as wool, dairy, bees/honey and eggs

Table 8.1 shows the number of farm businesses, area and total area of crop in Queensland for the past 5 years. Of all Australia's states and territories, Queensland had the highest proportion of agricultural land, accounting for 3% of total area of holding in Australia, an increase of 1.6% since 2015–2016 (ABS 2018a). Queensland is also the largest contributor to the area of grazing land, with an estimated 129 million hectares of land used for grazing in 2016–2017 (ABS 2018b).

Crops contributed AU$27.3b to the total value of agriculture in Australia, with wheat ($6.2b), fruit and nuts ($4.2b) and vegetables ($3.6b) being the largest contributors (ABS 2017a). For 2017–2018, the total value of Queensland's primary industry commodities (combined gross value of production and first-stage processing) is forecasted to be $19.45 billion, 2% less than the October 2017 estimate but 9% greater than the average for the past 5 years (Department of Agriculture and Fisheries 2018), accounting for around 24% of Australia's

Table 8.1 Agricultural statistics for Queensland, Australia

	No. of agricultural businesses	Area of farm (Ha)	Total area of crop (Ha)
2012–2013	26,647	129,548,236	3,270,474
2013–2014	26,786	139,932,697	2,302,145
2014–2015	25,512	135,917,925	2,407,354
2015–2016	18,153[a]	127,550,998	2,335,703
2016–2017	18,514	137,954,589	2,604,620

ABS (2014), (2015), (2016), (2017b), (2018a, b)

[a]The scope for the 2015–2016 Agricultural Census is different from previous ABS rural environment and agricultural collections. The threshold for including businesses in the 2015–2016 census was raised from an estimated value of agricultural operations (EVAO) of AU$5000 and over to AU$40,000 and over

agricultural production value (ABS 2017a), making Queensland a significant agricultural producer or around 8% of Queensland's economic output (Department of Agriculture and Fisheries 2018). The value of food processing and distribution in Queensland (incorporating manufacturing and retail and services) is estimated to be almost $14.3 billion for 2015–2016 for a sector which employs around 246,500 people (Department of Agriculture and Fisheries 2018).

Despite the changes in reporting practices, the actual numbers of agricultural businesses are declining. Rural Queensland is experiencing population decline in many areas. Between 2006 and 2011, there were around 20,000 fewer farmers, a fall of over 11% in just 5 years and a decline of over 40% from 1981 to 2011 (ABS 2012a). Drought and selected declining commodity prices have all contributed to this loss. This chapter outlines examples of current initiatives to address food waste and those emerging business opportunities including biofuture products (biochemicals and biofuels) through simple plate to paddock practices associated with recovery of urban collected organics for farm nutrients. There are also established and emerging opportunities for a range of commercial and industrial waste (resource) streams which provide valuable resources into high-technology nutrient fertilisers. Whilst there is more recognition and awareness to ensure that organics and valuable soil nutrients are captured and returned/recycled to farmland in a 'plate to paddock' approach, some of these 'waste/resource streams' have emerging and newly recognised risks associated with their application to farmland, particularly land used for food production.

8.2 Queensland's Climate

Queensland is a temperate and typically sunny state, ranging from tropical to sub-tropical conditions, with average summer temperatures of 29 °C and average winter temperatures around 16 °C. Most of Queensland receives more than half of its annual rainfall during the summer months (December–February) with average rainfall varying from less than 200 mm in the central-west region to over 3200 mm on the far north coast (Australian Government 2017a). Queensland benefits from a varied range of climatic zones and microclimates which facilitate a wide diversity of growing conditions and the ability, in some areas, to provide multiple cropping opportunities within a single year. As such, agricultural production is distributed across different climatic zones and also geographically. Much of the most productive arable land is located in the south-east areas or closer to the coast, whilst western parts of the state are dry and drought prone and more widely utilised for grazing purposes. Northern Queensland is affected by the seasonal migration of the monsoon across the equator. This results in a distinct dry season (May to September) and wet season (October to April), with the latter part of the wet season characterised by monsoonal activity. South-East Queensland is characterised by a range of climates from sub-tropical in the north through to temperate in the south, with a typically drier winter and wetter summer. This area is also influenced by large-scale atmospheric circulation drivers, particularly the El Niño-Southern Oscillation, leading to high variability and the occurrence of droughts and floods (CSIRO 2012). On the eastern Australian coast (Queensland and down into New South Wales), the formation of 'east coast lows' can also have a significant impact on water resources, resulting in intermittent large inflows into water catchments. This area has also been subject to considerable climate variability, including the Millennium Drought and the two wettest years on record for Australia (2010–2011) as a result of two strong La Niña events (CSIRO 2012). Queensland is the most natural disaster-prone state in Australia (ABS 2012b; Davis 2016). With an increasingly variable climate, impacts to agriculture will manifest, particularly in the frequency and intensity of extreme weather events ranging from longer dryer periods, intense flooding, fewer frosts and warmer temperatures for longer and increased maximums (WWF 2015). These events pose increased risks to soils in terms of soil loss and nutrient destabilisation. Temperatures in Australia were relatively stable from 1910 to 1950. Since then, both minimum and maximum temperatures have shown an increasing trend, with an overall increase from 1910 to 2010 of approximately 0.8 °C (ABS 2012b). Australia has warmed by approximately one degree since 1910. The warming has occurred mostly since 1950, and the frequency of daily temperature extremes has also changed since 1910 (Bureau of Meteorology 2017). The number of weather stations recording very warm night-time temperatures and the frequency with which these occur has increased since the mid-1970s. The rate of very hot daytime temperatures has also been growing since the 1990s (Bureau of Meteorology 2017) (Fig. 8.1).

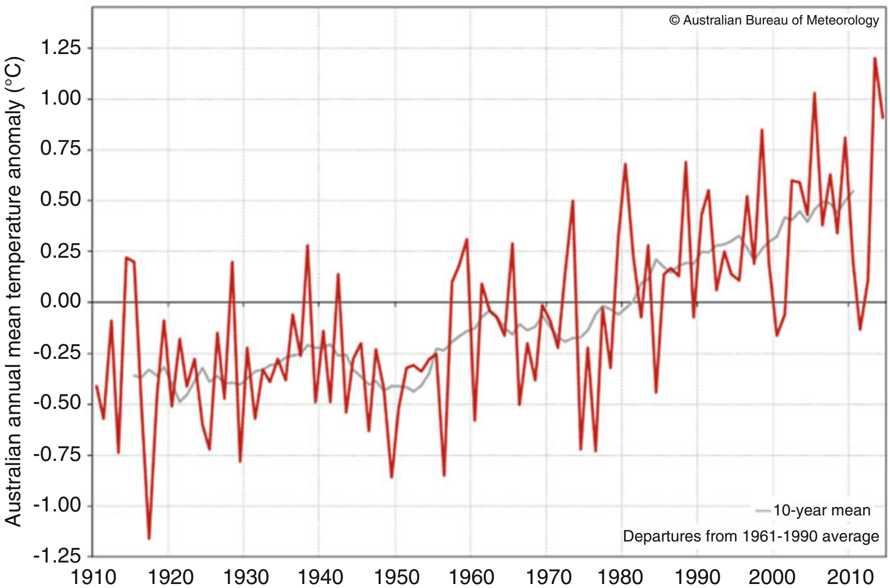

Fig. 8.1 Annual mean temperature anomalies for Australia (red) with 10-year mean (light grey). Departures are from the 1960 to 1990 average. (Source: Bureau of Meteorology, data from the Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT))

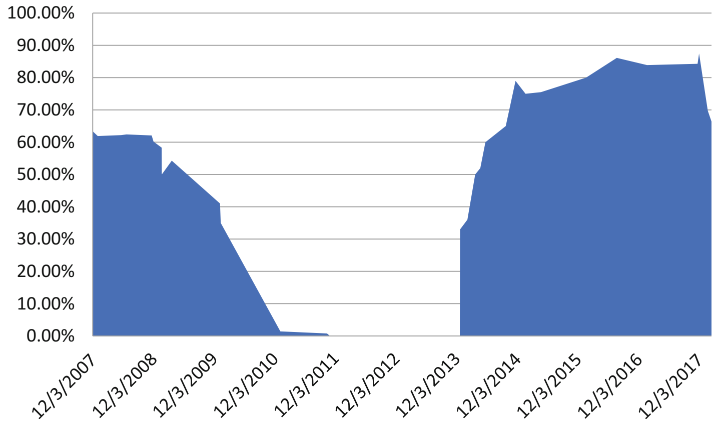

Fig. 8.2 Percentage of Queensland drought declared (2007–2017). (Source: Unpublished data)

The continuing impact of extreme weather events is significantly impacting primary producers across Australia, from crop damage to livestock stress. Climate change is exacerbating the effects of extreme weather events, such as drought, and rural and regional communities are disproportionally impacted (Climate Council 2016). Extreme weather or climate events include heatwaves, bushfires, droughts, tropical cyclones, cold snaps and extreme rainfall (storms, hail, floods) and extreme events are defined as the occurrence of a weather or climate variable above (or below) a threshold value near the upper (or lower) end of the range of observed values (IPCC 2012). These impacts are not uniform across the state. Drought figures compiled by Queensland's Department of Agriculture and Fisheries for the past decade illustrate the level and cyclic nature of drought across the state (Fig. 8.2).

Whilst there was a brief respite to drought conditions through 2011–2012 (which was a result of widespread flooding across many areas), this time was insufficient for many agricultural businesses to recover financially and rebuild strategic reserves or restructure crop and livestock (destocking) changes. For those who did, the subsequent drought conditions, which returned, and, for some areas, the degree of ferocity resulted in further stress. The Climate Council (2016) refers to climate change as a 'threat multiplier' in terms of its ability to exacerbate existing stresses on rural businesses and communities as well as adding new ones. Queensland farmers are now having to manage legacies, such as salinity which have arisen from historical poor farming management practices (e.g. in the Burdekin region) often exacerbated by drought and flood conditions.

8.3 Queensland Soils

Queensland's intense and episodic rainfall and the inherent instability of many of the soils result in a high risk of erosion. Soil is a precious non-renewable resource. Soil health and soil management, along with the availability of water, largely determine the level of food production. Healthier soils result in higher agricultural productivity, increased resilience of the land (and soils) to respond to an increasingly challenged climate and more prosperous communities. Soil can be lost forever due to intense rainfall when left unprotected or unsupported by appropriate land management practices. Recognising these challenges, the Queensland Government has been producing soil management guidelines since 1965 to provide support to farmers and land managers (Department of Science, Information Technology and Innovation 2015). Early European settlers to Australia had little appreciation of the limitations particular to the soils and landscape they were developing for agriculture and applied the farming practices with which they were familiar, those that worked in their homelands. Much of the cropping was undertaken without recognising the importance of retaining vegetation to conserve the soil and protect biodiversity; land subdivision was usually based on the simplest geometric, rectangular layout with little consideration of natural drainage systems, topography and soil types. These poor land practices were then incentivised by governments who offered incentives for wholescale clearing and cultivation.

Soil erosion was the first land degradation problem to become readily apparent in Queensland with cycles of intense and episodic rainfall and the inherent instability of many soils resulting in a high prevalence to a high risk of erosion (Department of Science, Information Technology and Innovation 2015). As a result, by 1950, large areas of cropping land in Queensland had become so badly eroded that they had to be withdrawn from cultivation. Queensland also has a range of 'difficult to manage' soils including acid sulphate soils, sodic soils and salinity. Soil sodicity, for example, is a natural feature of many Queensland soils, with approximately 45% considered sodic (Queensland Government 2018c). A common treatment for sodicity in soils is the use of gypsum to increase the salt content. By raising the level of salts in the soil, this helps to suppress dispersion. The application rate is typically determined on a paddock by paddock application given the diversity of soils and cropping systems. Plants need a steady supply of nutrients from the soil. Required in relatively large quantities are macronutrients including, but not limited to, nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca) and magnesium (Mg). Other nutrients are required in small quantities (micronutrients or trace elements) and include copper (Cu), zinc (Zn), iron (Fe), manganese (Mn) and boron (B). A shortage or absence of any one of these essential nutrients can adversely impact plant growth, whilst too much of any nutrient can also negatively impact plant health. The availability of nutrients is affected by the pH of the soil. For example, in very acid soils, manganese and aluminium may be present in toxic concentrations. The amounts of nutrients available in soils depend on interactions between soil properties from pH to soil type (clays, sands); soil biology including the organisms living in the soil breaks down animal and plant matter into nutrient forms that can be used by plants, the volume of organic matter and soil water. Farmer management of the soils also has an impact, for example, the use of chemical fertilisers through application of various irrigation techniques. Declining soil fertility through soil erosion and/or product removal has created the need for nitrogen addition. Nitrogen fertilisers are a significant expense for broadacre farmers, so optimising use of fertiliser inputs can reduce this cost, as can the beneficial use of waste products rich in nitrogen and retention of crop residues on agricultural soils. Sustainable soil management in Queensland currently focuses on the important issues of retention of surface residues, minimising wheeled traffic and managing soil nitrogen and other nutrients. Agronomic practices impact soil biota largely by the quantity and quality of crop residues returned to soil (Department of Agriculture and Fisheries 2017).

8.4 Organic Reuse and Nutrient Recovery from Wastes in Queensland

Waste is defined in the *Environmental Protection Act 1994 (Qld)* (Queensland Government 2018a) as including anything that is left over or is an unwanted by-product from an industrial, commercial or domestic activity. There are a range of requirements that are placed on the management of waste depending on its type or composition. The waste and resource management hierarchy needs to be considered when determining the options for managing waste. Reusing a waste is one of the preferred management options, second only to avoiding or reducing the amount of waste generated. Waste and recovered resources should also be managed as close to the source of generation as possible. A significant proportion of the wastes are rich in nutrients and carbon, which can potentially be used for manufacturing new high-performance fertilisers. However, there are some issues, such as heterogeneity of the waste materials and associated contaminants that need to be addressed prior to their reuses. Contaminants are substances that have not been intentionally added to food. These substances may be present in food as a result of the various stages of its production, packaging, transport or holding. They also might result from environmental contamination. Contamination generally has a negative impact on the quality of food and may imply a risk to human health with food safety and traceability becoming of increased concern to consumers. Currently a limited range of proven and well-distributed (fertiliser products as well as waste) products are available for farmers to manage complex soil constraints. For example, up to 50% of domestic waste are organic materials with other organic wastes including sewage sludge, food wastes and industrial food processing wastes. To address soil fertility constraints, increase crop yield and minimise environmental risks, there is an urgent need to employ cost-effective, innovative technologies to develop novel slow-release fertilisers and soil amendments to enhance the performance of soils. Recently in Queensland, and indeed Australia, there has been increasing rhetoric throughout the media on both the opportunities and risks posed by recycled and non-recycled organic wastes being spread to farmland stimulated, in part, by the adoption of more 'plate to paddock' approaches. During 2016–2017 in Queensland, a total of 4,363,000 tonnes of headline wastes was diverted from landfill disposal, an increase of 7.9% from 2015 to 2016. Of this volume, approximately 626,000 tonnes of segregated green waste was 'recovered' (through the use of composting techniques as well as direct land application), of which 73% was from domestic sources and the remainder from commercial sources, with organic processors converting 1.4 million tonnes of inputs (such as green waste, timber, forestry residuals, biosolids, manure, grease trap waste, abattoir waste, drilling mud and ash) into products such as soil conditioners, manufactured soil, potting mixes and mulches (Queensland Government 2018b). Other materials spread to land and for other beneficial use included approximately 972,000 tonnes (17.5%) of the 5.5 million tonnes of ash, as reported in 2016–2017, and 75,000 tonnes of waste (including green waste, timber, tyres, mineral oil and chemicals) was sent to energy recovery (Queensland Government 2018b). Table 8.2 shows selected wastes handled by Queensland's licenced (legitimate) organic processors including over 209,000 tonnes of green wastes, 72,000 of biosolids (dry solids equivalent) and 272,000 tonnes of manures. Geographical distributions of agricultural productivity (intensive animal activities through cotton) are reflected in the figures as organic wastes are typically processed in the region that they are generated. South East Queensland (SEQ) managed the largest amounts of green waste, timber, forestry residuals, biosolids, grease trap waste and other organic sludges, abattoir waste, waste food, food processing waste and ash. The Darling Downs–Maranoa processed the most manure and drilling mud, Fitzroy processed the most cotton gin trash (reflecting the off-site processing of cotton gin residuals – whilst other gins process on-site), and Wide Bay processed the most agricultural residuals.

There are limitations to the figures presented in Table 8.2. They do not include organic resources used beneficially on-farm either directly (such as manures spread to land) or on-farm processing (such as on-farm compost manufacture and use) or self-haul green wastes by households and some commercial enterprises to local government facilities (waste transfer and/or disposal facilities) which is often left to 'mulch' (often an uncontrolled and unmonitored compost-like process) on-site. Figures are also only collected from licenced organics processors – so those legitimate operators manufacturing over the 200 tonne 'licence threshold' of organic product per annum.

8.5 Waste Product Reuse to Land

There are a range of current regulations and approvals in Queensland for the manufacture and/or use (land application) of organic and inorganic products and the subsequent application to land, including farmland in Queensland. These approvals range from 'wastes' which have been deemed to have beneficial land use application to manufactured organic products, including green waste and mixed waste composts.

Table 8.2 Selected wastes handled by licenced organic processors in Queensland in 2016–2017 by region (tonnes)

Waste material	Region							
	SEQ[a]	Darling Downs – Maranoa	Wide Bay	Fitzroy	Mackay	Townsville	Cairns	Remote QLD
Timber, wood, sawdust	50,489	4896	15,168	224	646	3300	5393	0
Green waste	152,206	8290	1987	10,000	15,30	9500	11,536	0
Forestry residuals	155,156	0	31,610	40	0	0	0	0
Agricultural residuals	1630	0	8300	589	0	800	1000	0
Manure	60,357	185,916	5821	0	0	1175	18,829	0
Abattoir waste	30,533	2979	3726	5506	1000	0	0	0
Cotton gin trash	0	0	0	5185	0	0	0	0
Waste food	33,920	0	0	392	0	21	0	0
Food processing waste	39,107	0	1000	0	0	0	0	0
Biosolids (DSE)	61,449	6514	395	886	0	16	2963	118
Grease trap waste and organic sludges	98,713	2851	0	12,010	0	2204	1484	0
Ash	17,169	500	260	0	430	30	1000	0
Drilling mud	3400	44,334	0	28	250	0	0	0

Queensland Government (2018b)
[a]South East Queensland

8.6 End of Waste Codes

The *Waste Reduction and Recycling Act 2011* (Queensland Government 2018d) promotes higher resource recovery and recycling rates and aims to transform the perception of waste from being seen as 'waste' to being valued as a 'resource'. The end of waste (EOW) framework under Chapter 8A of the *Waste Reduction and Recycling Act 2011* promotes resource recovery opportunities. The EOW framework consists of codes and approvals. EOW codes are outcome focused, specifying outcomes that need to be achieved in order for waste to be deemed a resource. EOW codes relate to any registered resource producers for a code, whilst EOW approvals are considered on a trial basis for reusing waste as a resource for which an EOW code has not been developed for the waste. In approving a waste, conditions under which the resource is to be used are imposed onto the approval holder. A significant benefit of an end of waste code is that regulated wastes (when classified as a resource) are not subject to standard regulated waste transport and tracking provisions – except those specified in the EOW code or approval. General EOW codes include:

- Oyster shells (used for the purpose of constructing structures designed to promote the settlement of oyster spat)
- Fertiliser wash water and slurry
- Concrete washout wastes (including for the treatment of acid sulphate soils)
- Sugar mill by-products (soil ameliorant and conditioner for agricultural land and turf farm/compost or soil conditioner manufacturing, additive to soil used for landscaping)
- Coal combustion products (including reuse as a soil ameliorant)
- Irrigation of associated water (including coal seam gas water)
- Biosolids

There are also a number of general 'beneficial use approvals' issued under the previous regulatory framework which apply until their individual expiry:

- Foundry sand (and its addition to compost)
- Drilling muds (and its addition to compost)
- Irrigation of associated water (including coal seam gas water)

All of the approvals contain maximum permitted contaminant levels and limitations regarding their application. However, contaminant levels are typically based on guidelines from other states, and the available literature and approvals are not updated as information becomes available on new and emerging contaminants.

8.7 Green Wastes

Green waste includes grass clippings, tree, bush and shrub trimmings, branches and other similar material resulting from domestic or commercial gardening, landscaping or maintenance activities. In practice, the green waste data referred to in this report relates to separated material delivered directly to local government facilities and organic processors and does not include garden waste mixed with other materials in household waste bins. Green waste is sourced from both domestic and commercial sources of waste. Queensland's local governments played an important role in the collection and management of green waste, handling 91% of the total reported in 2016–2017 – of which over 500,000 tonnes was domestic waste self-hauled by residents to local council facilities (Queensland Government 2018b). In 2016–2017, a small number of Queensland's local governments provided kerbside bin collection services for recovering green waste (green bin lid) totalling 191,000 households (representing 10.3% of Queensland households) (Queensland Government 2018b). There are potential benefits to aerobically (and anaerobically) processing organic wastes to produce quality soil amendment products, including, but not limited to:

- Aligning with industrial ecology principles and the 'plate to paddock' philosophy
- Utilising a wide range of waste/secondary-resource streams to make particular products for a range of applications based on agricultural, nutrient or market assessments
- Recycling of nutrients, in particular, carbon, nitrogen, phosphorous, potassium and trace elements
- Replacement of synthetic fertilisers, which are often manufactured from non-renewable sources and the global cost of which has significantly risen over recent years
- Improvements to soil and plant health, including improvements to physical properties such as increasing humus levels and soil moisture control
- Addition of value to the Queensland economy through the manufacture of value-added products

There are also a range of benefits for local councils and, more broadly, for diverting organic waste from landfill including:

- Extending the useful lives of the existing landfill and in doing so deferring significant capital expenditure required for a replacement landfill
- Reducing greenhouse gas (GHG) emissions caused by the anaerobic breakdown of organic waste in landfills, which may include considerations for minimising any future carbon liability should a direct carbon tax for the sector be reintroduced
- Avoidance of the landfill levy

The quality of any final compost, mulch, soil conditioner product, etc., is heavily influenced by the input feedstock as well as the compost processing process (including pretreatment and post-treatment technologies). These considerations also influence costs in terms of opportunities for gate fees, costs of treatment per tonne and potential markets and market values of final products. However, there is increasing recognition of the role of plastics in organic fertilisers which can be a vehicle for entry of plastics into the environment (Weithmann et al. 2018; Ng et al. 2018; Browne et al. 2011) and which, in turn, may pose risks to biota and public health through their entry into the human food chain (van Cauwenberghe and Janssen 2014). Ng et al. (2018) pose that plastic particle loading in agroecosystems due to the application of fertilisers through to the application of plastic mulching is increasing. Most plastics (except for degradable and biodegradable) have been purposely designed to resist degradation. Research on the degradation of polyethylene (Albertson 1989) concluded that the degradation of polyethylene (PE) occurs at a rate of approximately 0.5% of weight per annum. The biodegradation of PE is primarily affected by irradiation from an ultraviolet source and other factors such as molecular weight, additives and surface area (Kawai et al. 1999). For example, increased branching of polymers reduces the rate of degradation, and additives can be used to weaken the carbon–carbon backbone of a polymer, whilst microorganism attack on PE is a secondary process (Scott 1975).

The composting of PE in some European countries, such as Germany, is prohibited as PE is unable to pass their standards governing compostability. Germany's standard DIN V 54900 (testing the compostability of polymeric materials (German Standards Agency 1998)) defines methods for testing the compostability of a polymeric material. The test indicates if a polymer will be disintegrated and converted into constituents of the compost under controlled composting conditions. This standard also determines if the composting process or quality of the final product is affected by the polymer or its degradation products. The word 'degradation' implies a loss of properties. The trigger for degradation could be a 'microbially, hydrolytically or oxidatively susceptible linkage built into the backbone of the polymer' or, alternatively, 'additives that catalyse breakdown of the polymer' (Narayan 2000). This 'trigger' can be specifically designed to ensure degradation does not occur within the 'in-use lifetime' but will begin upon disposal within a given environment. Degradation of plastics will ultimately depend on several factors such as the microbial activity of the disposal or treatment environment. Within a composting environment, thermo-oxidation plays the dominant role in degradation, since temperatures can easily exceed 60–70 °C for a prolonged period of time. Plastics can also degrade in a variety of ways through reacting with sunlight (photo-oxidation), bacteria (microorganisms), chemicals and macro-organisms (invertebrates and insects). However, compost windrows containing plastic contamination typically experience lower average temperatures (Davis 2005) which may lead to retardation of the composting process and poor pasteurisation outcomes. Whilst visual contamination of plastics in composts and soil ameliorants is worrying, of most concern is the prevalence of nano- and microplastics as well as the range of additives applied to plastics (inks through metals designed to facilitate the degradation process); and what happens to all of these materials in the environment long term as they degrade into various intermediately products?

Whilst organic wastes (food and garden) from households and commercial enterprises are a valuable source of materials for manufacture into nutrient-rich soil products including composts, biosolids and digestates, plastic contamination within the feedstocks or introduced via the processing has the potential to distribute plastics into the environment, particularly when 'beneficially applied' to soils utilised for the production of food. For example, analysis of a range of organic products used for agriculture identified up to 24 microplastic particles (i.e. particles under 5 mm) per kilogram, and as high as 895 microplastic particles per kilogram in biowaste digestate (Weithmann et al. 2018). Although there is increasing research on plastic and emerging contaminants, particularly those entering agroecosystems, considerable uncertainty remains given the limited number of studies to date. There has also been limited research to document and collect evidence relating to the effects of these contaminants and what suitable loading concentrations may be appropriate.

8.8 Biosolids Use

Raw sewage includes a supply of water and a solids component which is rich in essential nutrients such as nitrogen, phosphorus and organic matter; and these are in a form that is highly suitable for assimilation by plants (New South Wales 2000). As such biosolids producers have been working with government regulators and end users (agricultural sector) to reuse both the water and solids (biosolids) components of sewage in a manner that is cost-effective, environmentally sustainable and safe from a public health perspective. Sewage treatment plants are the main source of biosolids in Queensland with production estimated anywhere between 30 and 50 kg dry solids per equivalent person per day (equivalent to 150 kg of dry cake per annum). The biosolids are produced as either a thickened slurry or a dewater cake and, more recently, pellets; and contain useful quantities of organic matter and nutrients such as nitrogen (N), phosphorus (P) and potassium (K) and lead to improvements in soil characteristics such as improved microbial activities and oxygen consumption. Beneficial use is now a prerequisite for disposal of biosolids in many developed countries, which has necessitated formulation of guidelines to prevent environmental contamination with heavy metals and pesticides, and infection of human and animal populations with pathogenic organisms, resulting in different classifications (such as Grades A–E) to control the end uses for the material (New South Wales Government 2000; Queensland Government 2016a). Whilst it is commonly accepted that the utilisation of nutrients in biosolids at or below agronomic loading rates are highly beneficial, there is increasing concern related to contamination of biosolids from both known and new sources and how the concentrations or leaching potential of these new contaminants will be impacted through further pretreatment (such as pelletisation to improve handling and reduce the amount of water being transported) or co-composting (to value-add to lower nutrient organic waste streams such as green waste).

Over 85% of the total biosolids in Queensland are produced within 50 km of Brisbane (Queensland Government 2017b) with 77,392 tonnes of biosolids (dry solids equivalent, DSE) beneficially reused (89.69% of the 86,288 tonnes generated) across Queensland. The majority of this reuse occurs in SEQ with nearly 48,000 tonnes (DSE) utilised by fibre (cotton) farmers in the agricultural region of Darling Downs–Maranoa. There are restrictions on the surface application of biosolids to pasture for grazing, and the promotion of the immediate incorporation into the soil reduces the likelihood of any organic contaminant accumulation by grazing animals, and their application is prohibited to food (horticulture) crops. Whilst the end of waste code (currently transitioning from the former general beneficial use approval (Queensland Government 2016a)) methodology sets strict guidelines on the level of stabilisation required, limits of pathogens and concentrations of heavy metals and pesticides, many of the emerging organic contaminants are not included in the required analysis with contaminants restricted to 'traditional' pollutants and by cost-effective laboratory analysis (Table 8.3). It is critical to note that under the conditions of the approval, it is the producer's responsibility to ensure the quality of the resource has been determined before providing it to the user (e.g. farmer). However, it is the user's responsibility to ensure that biosolids are of a quality that is suitable for the land application use they will be undertaking.

The approval also determines quality characteristic requirements for one or more of the classifications of use (Table 8.4) ranging from unrestructured to restricted.

Thousands of new contaminants enter the market annually in common consumer products and are washed down our drains, ending up in drinking water, the marine

Table 8.3 Maximum contaminant limits

Quality characteristics	MCL (dry mass) in mg/kg		
	Grade A	Grade B	Grade C
Arsenic	20	20	20
Cadmium	3	5	20
Chromium (total)	100	250	500
Copper	100	375	2000
Lead	150	150	420
Mercury	1	4	15
Nickel	60	125	270
Selenium	5	8	50
Zinc	200	700	2500
Total organic fluorine	0.39	0.39	0.39
DDT/DDD/DDE	0.5	0.5	1.0
Aldrin	0.02	0.2	0.5
Dieldrin	0.02	0.2	0.5
Chlordane	0.02	0.2	0.5
Heptachlor	0.02	0.2	0.5
HCB	0.02	0.2	0.5
Lindane	0.02	0.2	0.5
BHC	0.02	0.2	0.5
PCBs	ND	0.3	1.0

Queensland Government (2016a)
ND Not detectable

Table 8.4 Biosolids classification requirements

Biosolids classification	Allowable land application use	Biosolids quality characteristics
Unrestricted use	Home lawns and gardens	The quality of the resource meets the following requirements:
	Public contact sites	(a) Maximum contaminant limit (MCL) in column 'Grade A' of Table 8.3
	Urban landscaping	(b) At least one pathogen reduction requirement and one vector reduction requirement for 'Stabilisation Grade A' of Table 8.4: Biosolids stabilisation requirements
	Agriculture	(c) Enteric viruses <1PFU per 4 g (total dry weight)
	Forestry	(d) Helminth ova <1 per 4 g (total dry weight)
		(e) *E. coli* <100 MPN per gramme (dry weight)
		(f) Faecal coliforms <1000 MPN per gramme (dry weight)
		(g) *Salmonella* species – not detected
Restricted use 1	Public contact sites	The quality of the resource must meet the following requirements:
	Urban landscaping	(a) MCL in column 'Grade B' of Table 8.3
	Agriculture	(b) At least one pathogen reduction requirement and one vector reduction requirement for 'Stabilisation Grade A' of Table 4: Biosolids stabilisation requirements
	Forestry	(c) Enteric viruses <1PFU per 4 g total dry weight
	Soil and site rehabilitation	(d) Helminth ova <1 per 4 g total dry weight
		(e) *E. coli* <100 MPN per gm dry weight
		(f) Faecal coliforms <1000 MPN per gm dry weight
		(g) *Salmonella* species – ND
Restricted use 2	Agriculture	The quality of the resource must meet the following requirements:
	Forestry	(a) MCL in column 'Grade C' of Table 8.3
	Soil and site rehabilitation	(b) At least one pathogen reduction requirement and one vector reduction requirement for 'Stabilisation Grade B' of Table 8.4: Biosolids stabilisation requirements

Queensland Government (2016a)
ND not detected, *NS* not stated, *PFU* plaque-forming unit, *MPN* most probable number

environment and in the resulting wastewater sludges. These contaminants are comprised of lawfully produced and retailed chemicals and pharmaceuticals through illicit drugs and, more recently, high-profile contaminants such as microbeads which are used as exfoliating agents in hundreds of personal care products globally. The perceived and actual impact of these physical contaminants and chemical compounds, particularly those which persist in the environment, bioaccumulate in both humans and the environment (particularly as they become concentrated in higher quantities and move up the food chain), and evidence of ecotoxicity, is growing. Contaminants from everyday products like shampoos, toothpaste and makeup are almost impossible to manage once used by the householder, whilst new organic contaminants arising from manufacturing and processing practices all end up down the drain, where the burden of dealing with them falls onto the wastewater systems. These newer contaminants have arisen from microbeads and nanoparticles in cosmetics to microthreads or cancer-causing nonylphenol ethoxylates (NPE) and phthalates in synthetic clothing with studies finding NPEs in 63% of the new clothing items it tested and phthalates in 100% of the samples and to a range of perfluorinated chemicals (Greenpeace 2012a, b). They also include antimicrobials and endocrine disruptors from medications and, more recently, potentially toxic levels of more ‘mainstream’ chemicals, such as caffeine (Davis 2017; Sidhu et al. 2012). There are over 143,000 chemicals registered for use in the European Union (EU) alone with researchers in the EU identifying over 140,000 chemical contaminants in wastewater sludge (European Commission 2001a, b), whilst in the United States, research has identified over 80,000 contaminants (US EPA 2009). Given that Australian consumers buy and use similar products to both the Americans and Europeans, we could assume broadly similar levels. A recent review has identified a list of ‘chemicals of concern’, including new organic contaminants (OCs) in biosolids used for agricultural use (McGrath et al. 2017). These include perfluorinated chemicals (PFOS and PFOA), polychlorinated alkanes (PCAs), polychlorinated naphthalenes, organotins, triclosan, antibiotics and pharmaceuticals. This review (McGrath et al. 2017) specifically noted a number of emerging OCs (namely PFOS, PFOA and PCAs) for priority research attention as they are ‘environmentally persistent and potentially toxic with unique chemical properties or presence in large concentrations in biosolids, that make it theoretically possible for them to enter human and ecological food-chains from biosolid-amended soils’.

Further studies have also noted a high volume of plastics (mirco and nano) in sewage sludges with concentrations of up to 300 particles per kilogram [dry weight] (Mahon et al. 2017; Li et al. 2018). Around 35% of microplastics in the oceans are thought to be fibres from synthetic textiles (Boucher and Friot 2017) released when washing clothes. Whilst human activities and products release microplastics to wastewater, wastewater treatment plants are effective at removing microplastics, retaining them in the solid fraction that may contaminate terrestrial ecosystems when applied as fertiliser (Prata 2018). It is important to acknowledge the significant volume of high-quality scientific analysis around the beneficial application of biosolids to land which has been conducted over 35+ years. Much of this research has determined that the majority of compounds studied do not place human or animal health at risk under current application rates and procedures (Clarke and Smith 2011; Fang et al. 2017). Much of this evidence and regulatory assessment has concentrated on total elemental content or single-step leaching procedures as the basis for its risk assessment. More recent studies have investigated leaching from soils associated with repeated applications of biosolids (and biosolids-amended composts) across a range of soils, even considering convection and diffusion effects from different application scenarios (Venkatesan and Halden 2015). At least one study has even considered the effect on soils and leachability from repeated applications of biosolids with a secondary material (such as fly ash), whilst other studies have determined that many persistent organic pollutants are not readily bioavailable to microorganisms and for plant uptake. There is certainly more work to be done on the actual impacts by heavy metals to plant uptake, soil quality and leaching to both surface and ground waters and, in particular, the transport and availability of new and emerging organic contaminants entering the market. Future research and regulatory assessment/conditioning must consider long-term impacts as well as immediate environmental risks. All stakeholders must continue to be vigilant to monitor and determine the significance of emerging OCs and plastic particles in biosolids. This research is essential for ensuring the long-term sustainable agricultural use of biosolids and in compost manufacture, whereas mitigating the risks of individual contaminants will require a range of possible policy, industry and consumer responses.

8.9 Assuring Organic Product Quality

A soil ameliorant must have a property that corrects an identified agronomic deficiency in land to which it is applied or, if incorporated into a soil conditioner product, properties on balance beneficial to safe use of that product. There are a range of Australian standards which apply to particular secondary-resource products, for example, AS4454 (Australian Standards 2012). This standard specifies minimum requirements for organic products which are used to amend physical and/or chemical properties of natural or artificial soils and growing media. The standard specifies physical and chemical requirements for composts, mulches and soil conditioners. Whilst many technical and management standards are not mandatory, they can represent best practice and can assist in improving the broader performance and perception of a company or facility. Standards are adaptive documents which are amended to reflect progress in science, technology and systems and should therefore represent best practice/guidance. However, the time associated to update these documents is prohibitive, and many of the Australian standards for organic products do not reflect 'emerging contaminants' or public concern around those contaminants. In 2013, the Queensland Government produced a guideline for open windrow composting conducted under environmentally relevant activity (ERA) 53 composting and soil conditioner manufacturing (Queensland Government 2013). The aim of the guideline is to provide clarity to project proponents and to ensure consistency in approval conditions (by government personnel) for open windrow composting, the most common type of composting in Queensland. The guideline has also been developed to create clear expectations for operators, communities and local governments and provides advice to assist facility operators in assessing the risks of environmental harm in the design and operation of their facilities, as well as complying with the general environmental duty (GED) per Section 319 of the *Environmental Protection Act 1994*. It is intended that the use of outcome focused instead of prescriptive conditions will result in shorter development assessment timeframes and more consistent conditions of approval. Under this guideline, and indeed the regulatory definition of compost manufacture (see ERA53, *Environmental Protection Regulation 2008*), organic wastes suitable for open windrow composting may include *a substance used for manufacturing fertiliser for agricultural, horticultural or garden use, animal manure, biosolids, cardboard and paper waste, fish processing waste, food and food processing waste, plant material, poultry processing waste and waste generated from an abattoir.* Organic wastes not suitable for composting include *organic chemicals (examples of organic chemicals are chlorinated hydrocarbons, lubricating greases, pesticides and tars), clinical or related waste, contaminated soil and plastics that are not compostable (except limited proportions of plastic which may be found in waste such as timber waste).*

8.10 Food Waste

As the global population rises towards the predicted 9.8 million by 2050 (United Nations 2019), there are increasing demands on, and opportunities for, Queensland's agricultural sector. An increasing global population is driving unprecedented demand for food, fibre and other higher-value products including bioproducts (including biofuels and biochemicals). Queensland is uniquely located in its proximity to Asian markets and is developing new transport and logistic infrastructure to expedite fresh product delivery to growth, often high-end markets. Whilst it is unrealistic for Australia (let alone Queensland) to be the 'food bowl of Asia', Australian food exports do provide sufficient calorific intake for 61,536,975 people, based on current average daily calorific intake of people in Asia (Australian Farm Institute 2017). Whilst Australia is an exporter of agricultural commodities (including beef cattle, sugar, cotton and pulses), many of these markets have been established on premium 'Australian-branded' produce for quality assurance and traceability (Woodhead et al. 2015), particularly high value-added protein foods, fresh fruit, vegetables and milk, through increasingly niche products, such as guinea fowl. Food waste, including food waste generated on-farm, is a rising social concern and is attracting a mix of regulation and aspirational goal setting globally. On 6 July 2017, the United Nations General Assembly adopted the *global indicator framework.*

There are 17 Sustainable Development Goals (SDGs) all with direct relationships to agriculture but most poignantly (United Nations 2018):

- Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture – world hunger is increasing. Conflict, drought and disasters linked to climate change are among the key factors causing this reversal in progress.
- Goal 12: Ensure sustainable consumption and production patterns – for example, the per capita 'material footprint' of developing countries grew from 5 metric tonnes in 2000 to 9 metric tonnes in 2017, representing a significant improvement in the material standard of living.

- Goal 13: Take urgent action to combat climate change and its impacts – noting that 2017 was one of the three warmest on record and was 1.1 °C above the pre-industrial period. Analysis by the World Meteorological Organization (2018) shows that the 5-year average global temperature from 2013 to 2017 was also the highest on record.
- Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss – about one fifth of the Earth's land surface covered by vegetation showed persistent and declining trends in productivity from 1999 to 2013, threatening the livelihoods of over one billion people. Up to 24 million square kilometres of land were affected, including 19% of cropland.

An estimated AU$20 billion is lost to the Australian economy through food waste annually, and the total cost of agricultural food losses to farmers is estimated to be AU$2.84 billion (Australian Government 2017b). Whilst major retails do impose cosmetic controls on produce, these controls are based on consumer expectations and perceptions of quality and product freshness being directly correlated to visual appearance. The agricultural sector has an established history of managing its waste streams effectively, ranging from innovative value-added products on-farm to combat food waste to organics and nutrient recycling and also bioenergy production.

Farmers in no way deliberately overproduce to create waste – waste is a cost in any manufacturing or 'growers' system and represents an inefficient use of resources. Farm production systems are carefully controlled operations that have been primed to deliver products in line with retailer contracts and consumer expectations. However, there still are situations where on-farm food/produce waste is unavoidable. Queensland farmers are leading the sector by driving supply chain innovation to find a market for these 'waste' products and, by doing so, adding significant value-added opportunities. These farmers are using produce normally rejected by consumer standards to create products that reimagine and work within the model of current consumer demand and will easily adapt to future digital (such as online grocery sales) and consumer trends including new ways of purchasing food. Notable examples of Queensland farmers embracing innovative opportunities in reducing waste include vegetable producers using waste carrot product and processing them into pre-cut bagged shredded carrot, circles and sticks. The solution took the previous 'ugly veg' problem and turned it into a successful value-added opportunity. In Far North Queensland, there has been the development of new products that turned 'banana seconds' into a range of gluten-free green banana flour products through a 'Natural Evolution' range. And in Bundaberg, one farm has addressed the issue of having avocado seconds by developing the first range of cold-pressed avocado products, a novel solution to an issue affecting blemished and bruised avocados, turning unwanted products into a convenient, dependable and 'ready-to-use' product that fulfilled customer demand. Many farmers and agricultural processors also have a long history of reincorporating organic waste streams such as straw and trash into the soils to beneficially incorporate soil carbon through bioenergy production. However, there are new 'biofuture' opportunities arising for the agricultural sector to value-add to resource streams and agricultural by-products to realise bioeconomy efficiencies and maximise financial returns. Research and governments are driving changes to policy and funding arrangements to maximise these opportunities which strive to move organic residuals and agricultural by-products up the value chain.

8.11 Circular Economy: Pressures and Pros

The agricultural sector is critical to the Queensland economy, providing food, fibre, foliage and, increasingly, fuel. The sector is instrumental in managing the challenges associated with population growth, food security, climate change and natural resource management. The circular economy is a widely coined term for a system that does not produce any waste or contaminants; instead materials flow (such as biological nutrients) and recirculate in the biosphere (ISWA 2015). A circular economy approach in agriculture centres on the production of agriculture commodities using the minimum amount of external resources, closing nutrient loops and reducing wastes and contaminant releases to the environment (Ward et al. 2016). Resources can be circulated through many pathways by employing technologies and creating new value chains. Ward et al. (2016) argue that the circular economy should be viewed differently to simply extending the 'linear chain' through the utilisation of wastes and agricultural by-products which are not returned to agricultural production (e.g. in the production of biofuels or other bioproducts), making the clear distinction that the bioeconomy uses renewable biological resources (agricultural wastes) to produce food, energy or materials rather than closing the resource loops in agricultural production systems. Queensland's Biofutures Roadmap and Action Plan (Queensland Government 2016b) provides aspirations to leverage the strategic advantages provided by the agricultural and other sectors to secure a share of the global bioproducts and services market, which is expected to be worth US$1.1 trillion by 2022. This biofutures agenda is broad ranging from biopolymer and biochemical production to biofuels and bioenergy production. Under this government-led policy, resources are not circularised; instead they are valorised to maximise financial returns. The Queensland Government's vision is for 'a $1 billion sustainable and export-oriented industrial biotechnology and bioproducts sector, attracting significant international investment and creating regional, high-value and knowledge-intensive jobs', taking advantage of Queensland's proximity to substantial Asian markets.

One element of this action plan is Queensland's biofuel mandate which seeks to increase investment in the biofuels and wider industrial biotech and bioproducts industry. The mandate enacted through the *Liquid Fuel Supply Act 1984* requires fuel sellers (fuel retailers and fuel wholesalers) to sell minimum amounts of sustainable biobased fuel. Since 1 January 2017, the sustainable biofuels mandates have set minimum requirements for the sale of biobased petrol and biobased diesel. The biobased petrol mandate requires that 4% of the total volume of regular unleaded petrol sales and ethanol-blended fuel sales by liable fuel retailers must be biobased petrol (ethanol), whereas the biobased diesel mandate requires 0.5% of all diesel fuel sold by fuel wholesalers to be biobased diesel (biodiesel). Biobased petrol and biobased diesel sold under the biofuels mandate must meet the sustainability criteria for biofuels. The sustainability criteria for biofuels help mitigate unintended environmental impacts from the expected higher demand for biofuels as a result of the biofuels mandate. The sustainability criteria are prescribed in legislation and include (Queensland Government 2018e):

- A greenhouse gas criterion that requires unblended biofuels, regardless of the feedstock, to deliver greenhouse gas savings of at least 20% when compared to regular petrol or diesel and
- Certification under the relevant environmental sustainability standard, which varies depending on the feedstock used to produce the biofuel

The biodiesel industry in Queensland has struggled with sourcing adequate feedstock. Whilst tallow is preferred, the high market value of tallow (upwards of AU$600/t) has been prohibitive, and other feedstocks, such as used cooking oil, have been diverted to other industries, such as the composting sector. Whilst the bioethanol industry has prospered through grain and, to a lesser extent, sugar molasses, providing both domestic supply and export to other Australian states, this has brought tensions between the intensive animal industry in Queensland which relies on grain as a feedstock and increased costs associated with the extra demand for grain from Queensland's biorefineries. To assist in the identification of organic waste streams for the bioeconomy, the Australian Government has funded an identification, mapping and reporting project. The Australian Biomass for Bioenergy Assessment (ABBA) seeks to catalyse investment in the renewable energy sector by providing detailed information about biomass resources across Australia. This information aims to assist project developers make decisions for new bioenergy projects and provide linkages between potential biomass feedstocks – through the supply chain – to end users. To achieve this, ABBA collects datasets, on a state-by-state basis, about the location, volumes and availability of biomass and publishes them on the Australian Renewable Energy Mapping Infrastructure (AREMI) platform (see www.nationalmap.gov.au/renewables). ABBA is managed by the Rural Industries Research and Development Corporation (RIRDC), with funding support from the Australian Renewable Energy Agency (ARENA). Data collected from the project is presented on a spatial data platform for Australian Renewable Energy Mapping Infrastructure (AREMI) which facilitates the addition of customisable layers. This data includes the types, locations and volumes of existing biomass resources (where possible identifying both total and potentially available resources); the types, locations and volumes of existing bioenergy industries; land capability for future biomass; and other related information including energy infrastructure (and current energy requirements), power utilities, transport infrastructure, population and land use data. In Queensland, data has been mapped and made available on the sugar industry, forestry, intensive animal industries, cotton, crops and horticulture (see Department of Agriculture's Web-based Agricultural Land Information

(WALI) system https://www.daf.qld.gov.au/environment/ag-land-audit/web-mapping-tool). Determining which policy position to adopt (closed-loop agricultural and nutrient cycles versus bioeconomy utilisation) is a trade-off which is unique for every waste stream, nutrient and technology application. All factors must be considered and analysis of whole of life impacts is essential. For example, new business ventures are utilising sugarcane trash as a commercial product, bagged and supplied to the gardening sector as a mulch. Whilst the collection and value-added process of sugarcane trash provides direct financial value to the farmer for a 'product' which, at face value, is a waste product, the loss of the nutrients (carbon) contained in the trash from the soil is a loss from the agricultural cycle. Ward et al. (2016) note that it is necessary to consider whether more value can be extracted from the unwanted (or unvalued) resource streams (e.g. protein or energy) and whether doing this interferes with nutrient and carbon cycles.

8.12 Discussion

There is increasing global concern and opposition to the spreading of mixed waste composts, compost-like organics (CLOs), stabilised wastes, manures and untreated biosolids to land, in particular to farmland. This has resulted in some jurisdictions setting high-quality standards for both organic waste treatment processes, and the resulting organic products and land/plant application limits, whilst others have moved to ban the application of mixed waste composts and CLOs to farmland. Concerns regarding the land application of these products include the impacts of physical pollutants such as glass and plastics, biological factors including pathogens and genetically modified organisms, animal diseases, the toxicity of heavy metals and, more recently as highlighted in the literature (Browne et al. 2011; van Cauwenberghe and Janssen 2014; Weithmann et al. 2018), the bioaccumulation of persistent organic pollutants and micro-pollutants. The early 'shred and spread' applications of wastes and untreated organics to land were driven by the desire to avoid increasing waste disposal charges, often as a result a waste and/or landfill tax. In these cases, many environmental regulatory authorities were slow to realise the loopholes, determine environmental harm and, in turn, control application or specify application rates. In many cases application rates were decided by farmers and, in some cases, the market value (or free of charge nature) of these products against the increasing price of traditional chemical fertilisers. It is also easier to define and prove environmental benefit than environmental harm, particularly where soils are weak or deficient in a range of nutrients or organic matter. As such, mixed waste composts and CLOs, in many cases, are able to easily demonstrate their beneficial application (as they do provide potassium, phosphorous and other nutrients as well as carbon), particularly in comparison to single stream (green waste) composts, whilst the contamination risks are harder to define and more expensive to prove. This is particularly true for the cost of analysis to identify micro-pollutants and the required commitment of undertaking longitudinal surveys to determine the risks of bioaccumulation or retardation of plant growth. In jurisdictions where food safety and/or environmental harm has arisen as a result of the application of unsuitable (organic) materials to land, some of the outcomes have ultimately been decided through the judicial process. For example, early applications of stabilised waste/mixed waste composts to UK farmland in the early noughties (primarily to avoid disposal costs, in particularly the landfill tax) were dealt with in court. This was as a result of Her Majesty's Revenue and Customs seeking to recover significant sums of outstanding tax or contractual breaches, and, as a result, detailed scientific analysis and assessment as to environmental benefit versus harm were undertaken. The volume of organic wastes collected in Queensland is set to continue to increase as more councils seek to implement organic (green/garden and, in some cases, kitchen) waste collections from householders and as disposal costs for commercial and industrial organic waste generators increase. This, in turn, will result in new technologies to process the collected organic and mixed waste streams, a greater volume of organic product seeking market opportunities and a greater range of organic product types. Land is valuable with viable farmland being the most precious. There is also a growing quality expectation and requirement for transparency surrounding the food chain. The large supermarkets globally have more power and are using it to specify rigorous purchase chain conditions for their food producers and growers, and export markets are sensitive to (perceived) quality. This rigour is being exercised by a growing number of countries, who look to import the best quality food available and which meets minimum safety requirements. Queensland is a significant exporter of quality produce, and, as such, it is imperative that Queensland maintains the quality of its farmland and food chain production standards. Any 'food incident' linked (not necessarily proven) to contaminated farmland would damage the reputation and demand for Queensland's produce. The pressure to grow more food, fibre, foliage and now fuel requires increased input and output intensity, particularly as the footprint of the available agricultural land is constrained due to regulatory and financial factors as well as access to water. As such, the need to return nutrients to soils to maintain productivity and protect soils from erosion through cropping and land management practices is critical. Yet, at the same time, there is increasing competition for organic nutrients from the bioeconomy and a recognition and public awareness of the contaminants in the organic nutrient streams we want to return to land.

8.13 Conclusions

Queensland's agricultural sector is vulnerable to global climate change impacts due to its geographical location and geological attributes through its reliance on climate-sensitive receptors. There are already signs of productivity fatigue and environmental stress throughout Queensland's agricultural sector. There are both continuing (growing populations, export markets) and new pressures (biofuels and bioproducts) on Queensland's agriculture to produce more whilst safeguarding the natural ecosystems and resource base (including soils). Much of the additional production must come from the intensification of land and water consumption currently under productive use. This is becoming more challenging against an increasingly changeable climate. Framing an energy-water-climate change ‘nexus’ for Queensland’s agricultural sector allows for the identification of critical interlinkages between natural resource management and factors such as agricultural productivity and provides an opportunity to identify the implications from uncoordinated decision making or government programmes. Domestic policy settings are critical determinants of agricultural productivity as they shape farmers’ incentives and capacity to innovate and improve productivity. The imperative of a strong, sustainable and resilient agricultural sector is essential to provide social and economic value to Queensland’s rural areas and provide food security. As such, there must be state-/economy-wide agricultural policy settings which create conditions conducive to innovation to ensure an efficient and effective agricultural sector.

The adoption of best practice management approaches for land and other resources (water, energy, soil, nutrients) is an integral component of sustainable agriculture. The high inputs into the intensive agricultural sector (irrigation water, energy, soil nutrients, fertilisers, etc.) and natural capital impacts (soil degradation, fresh water use) make reduction, where possible, a priority if we are to protect agri-food supply systems and sustainably manage increasing demand for fibre, foliage, fuels and other elements of the bioeconomy. Queensland’s agricultural sector is subject to competing policy and economic drivers. A circular economy approach must minimise upstream inputs (energy, water and fertiliser) and downstream residues and wastes (such as food wastes and manures) and ensure that nutrients are returned to land. A focus on the provision of evidence and modelling data in making innovative and adaptive decisions is critical for agricultural businesses. These models have important implications in policy planning and development towards minimising the impact of climate change on farming practices through biosecurity risks. Government departments and funding should facilitate knowledge and information access, so that agricultural businesses and their advisors can frame climate change adaptation actions and policies which focus on driving productivity, seizing opportunities and at the same time managing risks, particularly those associated with declining natural resources, rising input costs and increasing regulation. This will require consistent and holistic cross-government agency and multidisciplinary policy to address the competing demands on natural resources (including water and soils) whilst maintaining productive farming systems. It is assumed that a ‘circular economy’ approach for agriculture offers benefits to Queensland’s agricultural sector from an economic, social and environmental perspective – but this adoption could be at the expense of economic and value-added opportunities offered through the bioeconomy, whilst a purely bioeconomy approach, which may maximise on-farm returns by valorisation of by-products, risks diverting critical and, in some cases, limited nutrients from the biosphere. There has been limited research to date to document and collect evidence relating to the effects of existing and emerging contaminants on the agroecosystems and what suitable loading concentrations may be appropriate. In the meantime, do we need to consider precautionary measures until the science is available?

There are several guiding principles of environmental policy set out in the Intergovernmental Agreement on the Environment, including the 'precautionary principle', 'intergenerational equity' and the 'conservation of biological diversity and ecological integrity'. This agreement was designed to provide a mechanism to align the decision making between states and Australian Government and to facilitate better environmental protection. Within this agreement, Section 3.5.1 states the precautionary principle as:

> Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by 'careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and an assessment of the risk-weighted consequences of various options.

Actions to mitigate plastics (including nano and micro) and other contaminant emissions to land will also benefit the broader environment and communities. Rural communities across Queensland are naturally resilient. Many of the landholders and rural communities have substantial experience of extreme weather events, climate variations and utilisation of their on-farm resources, but these challenges are escalating, and more innovative and coordinated adaptation is required than ever before. This includes the provision of data and science so that farmers and other landowners can make informed decisions relating to the destination of their products and by-products, as well as sustainable land management practices.

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Chapter 9
Creating Sustainable Energy for Future Generations

Dumitru-Alexandru Bodislav, Florina Bran, and Carmen Valentina Rădulescu

Abstract This research tries to highlight what is needed to be done for us and our future generations to create a sustainable mechanism that is green, scalable, and secure for the way we develop and obtain energy from a purely economic perspective. The debate today is about yields when it comes to solar, wind, and hydro- and geothermal paths in producing energy, a fact that is counterbalanced by nuclear energy and the traditional coal-based energy, which still have a better economic positioning and financial output than the renewable solutions. The authors will try to introduce also the states involvement in the process, from institutional, ideological, political, and pragmatic perspective. Regarding the outcome of this research, the emphasis will be on how the standard of living will be improved, not only for our generations but also for future ones.

Keywords Sustainable energy · Regulation · Deregulation · EU's strategy

9.1 Introduction

The public sector made of state-owned companies is mostly seen as an efficient mechanism for fulfilling macro-goals in European countries, especially in emerging ones, because the public sector can reach allocation efficiency, target a higher rate of employment, and push the growth of the entire economy. To this feature we could add that it develops the layers of the corporate governance structure (Bodislav 2014). Opposite to the European way, there are the Japanese and American ways on developing a country, because they employ small involvement in nationwide development of the public sector (Brackman et al. 2009). In the 1990s, there were macroeconomic policies based on privatization, but the trust in local governments was reduced and government spending was at its peak.

D.-A. Bodislav (✉) · F. Bran · C. V. Rădulescu
Bucharest University of Economic Studies, Bucharest, Romania
e-mail: dumitru.bodislav@economie.ase.ro

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In Europe privatization was scaled at macroeconomic level, reaching France and the UK in the 1990s. In 1986 Italy adhered to this policy, followed by Spain and Germany in 1993. During the 1979–1999 timeframe, in Europe privatization changed the microeconomic environment because it empowered the private sector in its relation with the state, and to this we can add the technological advance which eliminated most of the monopolies on the market.

Technological advance was also empowered by telecom and energy sectors, to which we could state that information technology largely neutralized natural monopolies and streamlined oligopolistic positions by increasing allocation efficiency. Modern man-made monopolies are seen through nationalization of companies, similar to TARP in 2009 (Bodislav 2013a), or the process of nationwide nationalization in Hungary between 2015 and 2018. In the case of oligopoly, we have the evolution of shaping a market by mimicking oligopolies by using companies created through technological advance. In 1984 there was AT&T as example which later on was sliced in smaller companies in the idea of reducing costs and redeveloping the sector of the economy. In the cases of monopolies and oligopolies, there were state-owned companies that don't have as main goal to create profits, because they have the option to work at a loss that isn't always a negative component because it fulfills the goal of the public sector (Bodislav 2014). The entity operates by using the price = marginal cost principle; fixed costs are sunken costs and are covered from the public budget and by using the allocation efficiency principle.

9.2 Regulating Markets: Advanced Economic Issues

Adam Smith's *Wealth of Nations* highlights the idea of regulation by using the many advantages that a seller could have in his relation with the buyers (Smith, 2011). In the 1970s Stigler achieved the idea that regulation creates two macro-ideas: it helps reallocate wealth and increase costs with waste in the economy, and this way interest groups will want higher regulations from the government and will try to mimic how a public good works, but meanwhile they'll try to shift the new regulations toward their benefit. Stigler (1971) highlighted that if the state empowers the industrial sector, the marginal benefit of that industry decreases and the entire sector underperforms. Politicians are the main driver when it comes to developing regulations, but not with the purpose of deceasing market imperfections, but to serve the needs of interest groups that offer them some benefits for their service (support for reelection – financial, expertise, or moral). Stigler has seen regulation as a complicated mechanism used for profit by quantifying the interest group's needs (Anderson 1998). The advancement in telecom and energy technology starting with the early twentieth century was in line with actual monopolies in the late twentieth century and the beginning of the twenty-first century (Zajicek 1999). AT&T and Chicago Commonwealth Edison included as supervisor the American government and pushed regulations through their policies, but not for empowering the benefits for the consumer but for transforming themselves in long-run monopolies. This represented the idea of company-generated state regulation that closed industries and geographical penetration for newcomers (Bodislav 2014). Stigler also highlighted that modern regulation is biased toward helping the companies, not the general public and macro-interest (Peltzman 1976). Peltzman used to see regulation as an auction, where politicians would "sell" their service to the highest bidder, the bid being seen as lobby or bribe toward reelection. The best seen solution for regulation is seen when both parties are optimized (consumers and producers). Niche regulation most of the time empowers one side of the deal, and regulators shift benefits from one party to another by using the marginal utility function. Rent-seeking behavior is present when it comes to opening or creating a new set of rules or regulations, and political entities try to take their share of the deal.

The only natural element in this situation is that we have competition as equilibrium generator between government regulation and economic efficiency (Taleb 2010). In 1983, Becker realized that regulations create borders and develop inefficiency and help interest groups in pressurizing politicians to act on their behalf. Peltzman and Becker researched that continuous investment in lobbying creates some dangerous shifts in policies on the long run, and regulatory behavior is killing any deregulation present on the market. Peltzman and Becker highlighted that economic theory uses increased marginal benefits to explain the behavior of politicians and why some interest groups shift from one side to another. Usually deregulation was used to explain why loss-loss situation happened in the past, where energy producers and consumers had their marginal benefits reduced, and this also represented the key to shifting toward regulating the economy instead of deregulating it. The Chicago school of thought and the Austrian way of economic thought stressed that a regulative economy that uses methodological individualism and sensitivity in market behavior could help solve the irrational behavior of governments and ignite to peaks for competition (Bodislav 2014).

9.3 Deregulating Markets: A Path that Could Provide Long-Term Muddling Through

A counterintuitive example on total deregulation is the state of California and the timeframe when they deregulated the power grid and energy market. The free trade generated and based on demand and supply seemed to be a perfect market, especially when long-term contracts were banned and all transactions were made on the spot price through an independent system operator (Bodislav 2013a). The system marked to market only after a volume was reached, a fact that left the door open for suppliers to manipulate the market and be molded similar to monopoly system. Companies like Enron and Dynegy profited also from deregulation and also from market inefficiency. Instead of decreasing prices, the deregulation law spiked the actual prices and generated regional monopolies inside California that also empowered the growth of barriers for future suppliers, and this way the market got closed for new suppliers between 1985 and 2005. A secondary output was that imports from Canada increased, and in 2001, a “black swan” situation was validated (Zajicek 2001) through the fact that California had a cold winter and a hot summer, followed by a spike in the price of natural gas and the bankruptcy of corrupt and greedy Enron; because of these factors, the market collapsed, and suppliers stopped selling electric energy to consumers (Bodislav 2013b). The “deregulation law” transformed into one of the biggest failures of the century. Although time has passed, countries from Eastern Europe are keen on deregulating their power grid and suppliers, and with the help of politicians, businessmen, scholars, and the Internet, these countries will face global lobbying shifted toward deregulating their markets, and new players will run the show, especially those from countries that are already developed on this side of the industry. The fact that these CEE countries are also members of the European Union increased the chances of powerful failure of the system because these countries are interconnected between them. Another common feature of these countries is that they are all ex-communist countries, and their experience is shifted toward a political class that serves for the common good of interest groups but not of the people. There is a sudden need for a shift toward business development inside public utility companies that are controlled by politicians and creating economic hybrids that are state-owned, but privately run. Government regulation should be diluted (Peltzman 1989: Schwarz 2001), and the regulation that will be in power should be benchmarked before using them.

9.4 A General Overview on Privatization of Energy Markets

Most of big state-owned companies operate with loss, but they don’t have a negative output just because of bad allocation inefficiency, but mostly because of underperforming management, macroeconomic environment that is not biased toward policy making for pushing economic growth to new heights (Bodislav 2015). We could find these issues inside big privately owned companies that are sometimes in monopoly positions and that run immense cash flow, like the case of Gazprom, but at the end of the fiscal year, the financials show small to nonexistent profits. Inefficiency in state-owned companies is also based on lack of stimulus and discipline for the top management of those companies. To dilute the lack of motivation, we need to stimulate the entire flow of the processes behind due diligence and corporate governance, but not only linking bonuses to profits but also with trends and the dilution of the company’s monopoly (Finsinger and Vogelsang 1985). Stiglitz (1988) highlighted that in some countries another measure that postpones performance in the public sector is the push a ceiling for salaries for top managers, that ceiling being that salary of the country’s president. In the USA, the job of state-owned manager has these limitations, but also it has the safety net of having in your hands the tool of privatizing the company.

Comparing profits from state-owned companies and privately owned companies is not healthy from an economic perspective because the first one doesn't have as key performance indicator targeting a big profit margin. The North American healthcare system is based on cost principles, but has different output targets, and the state-owned medical system firstly targets increasing the quality of life and secondarily reaching breakeven on costs; meanwhile the privately owned healthcare system follows the idea of saving the patient, but being cost-effective, and also reaching as secondary goal a bigger profit margin and of which a huge part is reinvested in research and development (Bodislav 2015). According to Milward and Parker (1987) and Stiglitz (1988), the state-owned healthcare system uses 2% of its income, while the privately owned one uses 30–40% of its income. Stiglitz also underlines that there are sectors of the economy that could be only covered by state-owned companies, because they are the only ones that could internalize the losses.

9.4.1 The Impact of Privatization of Energy Sector in Great Britain

The impact of privatization on welfare is part of economic evolution. During the 1970–1980s era in Great Britain, the rate of inflation skyrocketed, and as a reduction measure, they implemented large-scale privatization and its key feature, allocation efficiency, which although allows us to have an ascending trend on prices, the slope decreased and stabilized them in the long run. For utility companies in Great Britain, the governments targeted price ceilings until 1989, and although it was seen as a shift of the burden toward the consumer, the ceilings limited investments from the private area and pushed public investment which was supported by the taxpayers (Bodislav 2015). In Great Britain the distribution system for natural gas reached its privatization in 1986 and resulted in lower prices for the final consumer but also targeted by the state with price ceilings. British Telecom was privatized in the same period and price ceilings were established, but the outcome was different compared with previous situations; although the company increased to its maximum tariffs because of the lack of competitors, the overall tariff level decreased because it was a liberalized market. These opposite results on the same situation are a result of the macroeconomic perspective of policies and consumer behavior, but all changed with the evolution of technology, especially in the telecom industry. In the waterworks utilities sector, costs rose rapidly as an increase in new environmental policies and healthcare measure for the consumer. One big component of privatization was restructuring that can be largely implemented, but with huge financial and social costs, in the case of British Coal, the European Union modified the structure of obtaining classic thermo-energy by not only using coal but also by adding other fossil fuels to the mix, and in this way the ratio evolved from 92% coal, 7% oil, and 1% natural gas to 63% coal, 32% natural gas, and 5% oil, components that had a higher cost (Bodislav 2015).

The electric energy bill for the end consumer decreased especially when nuclear energy came into play and when France exported to the British market large quantities of electric power. Between 1984 and 1994, the number of coal miners decreased from 250,000 to 7,000 because of the decrease in the consumption of coal, a fact that skyrocketed the social cost (Newbery and Pollit 1997). Another example is the British Gas, which was a privatized company that remained a monopoly after privatization; its status quo was maintained, and all the financial burden was shifted toward the end consumer. The National Grid Corporation and British Energy controlled the market, but not as monopolies but more like a pseudo-cartel. One peculiar situation was seen in the transportation industry, because the industry itself reduced its efficiency, but one key global player was born, British Airways.

Great Britain's economy was healthy before the privatization era, but evolved beautifully under Margaret Thatcher's hybrid ruling, including here the UK Monopolies and Merger Commission, an entity that was the opposite of the laissez-faire economic evolution. Emerging economies could learn from the privatization of Great Britain some lessons regarding development of economic models for their national economy, by using regulation and privatization as paths toward creating deregulated-like outputs for the economy; this way foreign investors will be attracted in investing in the periphery of the economic model of the European Union.

9.4.2 The Energy "Drive": The Sustainable Future Offered to Our Next Generations

The importance of the energy field in the future evolution of ecological crisis has been demonstrated in the second and third parts of this chapter and, at the same time, by international organizations proposing new sustainable energy policies to mitigate the negative impact of fossil fuels on the environment to overcome constraints on resource depletion and centralization of energy systems characterized by local dependence on the national grid and lack of flexibility in access to energy (Midili et al. 2006). In this context, this chapter aims to discuss sustainable energy policies implemented at the European Union level to overcome the paradox generated by the relationship between economic progress and worsened natural environment by investigating major energy issues related to climate change on the global stage within/due to the energy sector.

As a natural consequence of the research initiated in the third part of this chapter, the EU targets and their outlook are assessed in order to highlight the possible risks of nonfulfillment, as well as the benefits to social welfare. This objective is overcome by the following questions: Are the aspirations of the EU Member States to develop green energy to reduce GHG emissions, considering the increasing demand for global energy, sufficiently ambitious in the context of the current challenges? What is the status and evolution of Romania in this context? The importance of responding to these questions arises precisely from the need to design and implement coherent, efficient, transparent, and equitable energy policies at the European level and implicitly in Romania.

9.4.3 European Union's Targets on Energy and Climate

With the unanimous international recognition and recognition of the role of energy in the global problems posed by the natural environment by the development of socioeconomic activities, especially climate change, which subsequently reacts negatively to the "society" complex and which, in the energy sector, is materialized in the form of negative effects on the environmental factors generated by the type of currently exploited energy resources and inefficiencies in the production, distribution, and use of energy in its various forms, the specialists in this field formulated legislative policies and directions, imposing measures ameliorating paradoxical relationships between the natural environment and economic growth. Zamfir et al. (2016) argued the need to stimulate the implementation of renewable energy by presenting advantages such as diminishing the dependence on imported energy, ensuring energy security, improving the quality of life, creating jobs, increasing competitiveness, and supporting sustainable development and, on the other hand, by identifying current challenges such as the discontinuity of renewable energy generation, infrastructure that does not meet the needs of these energy sources, consistent initial investment, low competitiveness, and degradation of the natural ecosystem through pollution and biodiversity damage. At the same time, green energy development policies call for a significant improvement in energy efficiency in the context of climate change, which in fact refers to energy saving by reducing consumption. In order to substantiate these policies relating to the relationship between the natural environment and the energy system in practice, simple or complex indicators are used to monitor, assess, and estimate specific aspects of a general problem, such as GHG emissions indicating a state of the significant environmental climate factor or the environmental performance index, which reports the state of the environment at a certain point in a given space. Two cases are exemplified in the field of energy, energy consumption and low energy security, which can negatively influence both the amount of atmospheric emissions that intensify climate change and the socioeconomic development of the medium and long term.

The importance of these policies adopted by each state generates an important political message of supporting and encouraging investors by providing a clear and stable legal framework allowing simplistic procedures to reduce bureaucracy (Abdmouleh et al. 2015). These energy policies mainly use indicators or indicators to measure progress on green energy development and green economy as well as the impact of human activities on the environment (Mundaca and Richter 2015). According to the World Resources Institute (WRI 2015), between 1990 and 2012, the EU28 significantly reduced its contribution to total global emissions including LUCF, with a contribution of about 8.66% to total world emissions in 2012 compared to 15,14% in 1990, being located after the USA in 1990 after China and the USA in 2012. Also analyzing GHG emissions per capita worldwide, the European Union decreased them at 10.86 t CO2 per capita in 1990 to 8.22 t CO2 per capita in 2012, which is characterized by a difference of 4.43 t CO2 per capita that is above the world average in 1990 and 1.47 t CO2 per capita that is above the world average in 2012. In addition, it is remarkable that this indicator has been decreasing at EU level compared to other regions since 1990, being placed in 2012 after Australia, Canada, the USA, Russia, Japan, and a few other states belonging to other continents. Thus, the BRIC, the USA, and the EU are noticed as the most polluted regions globally. Moreover, there is an increase in the share of emissions from the energy sector in total global emissions, demonstrated by 69,51% of this indicator in 1990 and 73,74% in 2012. The European Union has contributed to the energy sector of 82,24% in total EU28 emissions in 1990 and 88.11% in 2012, respectively (WRI 2015). It is noteworthy in this context that the European Union has adopted energy policies to reduce GHG emissions much more efficiently over time. In this context, a number of European Union publications and legislation have recently been developed to develop the green energy field, targeting the use of renewable sources with a low impact on human health, biodiversity, and natural environment, the use of energy-efficient products and services, as well as the realization of energy saving. However, indicators that monitor the evolution of these targets in the relationship between energy and climate change only aim at adopting renewable energies and achieving energy savings.

Thus, EU Member States have assumed different climate and energy-related change targets, building on the Kyoto Protocol proposals, sustainable economic models, and, more recently, the Paris Conference of 2015 on mitigation and adaptation to climate change. The EU's energy legislative framework proposes measures to maintain at the most the current global warming, highlighting the need for global commitments that, at the same time, address the challenges of energy security and security, the internal and external dimensions of the energy market, energy efficiency, technological progress, and innovation (European Commission 2010a). On the whole, the EU predicts an increase in energy demand, due inter alia to the access of all citizens to energy, and finds much higher electricity prices in the EU than the USA and China (Capros et al. 2009; European Commission 2010a). But, more recently, in a report in 2016, Capros et al. (2016) indicate that energy consumption is more energy efficient due to the green policies pursued, thus predicting the decline in energy demand with the rise in social welfare by 2050. But the issue of rising energy prices remains a challenge in these more recent scenarios (Capros et al. 2016). However, energy issues find their way in promoting renewable energies and increasing energy savings by improving energy efficiency and energy conservation. The EU notes that over a period of 5 years, jobs generated by the green energy industry have increased by about 320,000 (European Commission 2011), demonstrating support for the social dimension through the adoption of green energy, but it should not be neglected the loss of jobs in the fields based on the use of fossil fuels. In this context, the EU and, in particular, the Member States are currently building national plans for considering the relationship between energy and climate change, for the adoption of concrete national measures for this relationship, which is expected to be ready in 2018 (European Commission 2015a).

9.5 Expectations and Perspectives: Saving Energy

The EU assesses the state of energy savings through primary and final energy consumption. The EU energy efficiency targets for 2020 and 2030 are proposing 20% and 25–30% improvement in energy efficiency compared to 2005 (European Commission 2015a). According to the European Commission, the EU should save 2.7 Mtoe in final consumption per year and 11.9 Mtoe in primary energy consumption compared to 2013 to meet its 2020 energy efficiency improvement target of 1086 Mtoe and 1483 Mtoe (European Commission 2015b). It is noted that the 2020 target for final energy consumption and primary energy consumption was reached and exceeded by 18 and 19 countries from the 28 EU Member States in 2014 as well as by the EU as a whole for final consumption of energy. However, the primary energy consumption of the EU will have to decrease by 1.6% as compared to 2014 to reach the 2020 target. Moreover, the EU's final energy consumption decreased by 1.84% between 1990 and 2014 and by 10.96% between 2005 and 2014, while the target for this indicator set by the EU for 2020 would mean a decrease of 8.88% compared to 2005 and an increase of 0.45% compared to 1990. At the same time, the primary energy consumption of the EU decreased by 3.97% between 1990 and 2014 and by 12.01% between 2005 and 2014, while the target for this indicator set by the EU for 2020 would mean a decrease of 5.51% compared to 1990 and by 13.42% compared to 2005. In addition, under these circumstances, the EU highlights the difficulties of meeting the 2020 energy efficiency targets (European Commission 2011).

Romania has assumed less ambitious targets on energy saving, as the target for final energy consumption for 2020 would mean a decrease of 25.74% compared to 1990, but an increase of 22.67% compared to 2005, which represents the minimum recorded level for 2 years, whereas the target for primary energy consumption for 2020 would decrease by 24.96% compared to 1990, but an increase of 17.17% compared to 2005. Thus, Romania should reconsider the targets in the field considering the minimum value of the two indicators, realizing efforts to reduce energy consumption. Thus, concrete measures need to be implemented and not just adopting targets based on contextual conditions. In 2014, Romania's final energy consumption decreased by 46.81% compared to 1990 and by 12.15% compared to 2005, while primary energy consumption decreased by 46.25% compared to 1990 and by 16.08% compared with 2005, with energy savings being much higher than those recorded by the EU. In conclusion, Romania's top position regarding the reduction of energy consumption is not due to the implementation of intensive energy saving measures but rather to the economic context generated by the socioeconomic restructuring after 1990.

9.6 Conclusions

Current EU policies aiming at the sustainable development of energy and society in general are promoted in close correlation with the theme of climate change. Energy consumption is the main driver of GHG emissions, whose evolution is being continually analyzed to assess the justification and timeliness of old and new policies to mitigate climate change as well as sustainable energy. It has been shown that the EU28 contributes significantly to global emissions with about 8%, although the evolution of this percentage is decreasing. It has also been shown to reduce GHG emissions both aggregate and relative to the size of the human population over the period 1990–2012, but it should be noted that the EU is still among the top three most polluted regions globally. In addition, GHG emissions from the energy sector increased between 1990 and 2012, both as a global contribution and as a total share of the EU. In this context, the EU legislative framework supports the need for international commitments to address the climate challenge together with proposing numerous measures to improve sustainable energy security by addressing the energy market dimension and technological and energy-related challenges (European Commission 2010b). Recently, Capros et al. (2016) published a report highlighting the progress made by the EU in energy efficiency through green policies, anticipating a reduction in energy demand with increasing social welfare by 2050. However, the possibility of a considerable reduction in energy demand in the near future is questionable in the light of the need for economic development of the new Member States, the EU13, and bearing in mind that, for the time being, at EU27 level, the increase in energy consumption determines economic performance. Under these circumstances, researchers and governors propose various analyses to estimate the relationship between GHG emissions, economic growth, energy consumption, and other indicators of the socio-ecological complex that contribute to the intensification of climate change, as was done in Chapter 3 of this paper. Thus, this chapter sought to assess the achievement of the EU and Member States' targets by analyzing the targets for energy and climate and designing scenarios for their evolution on the basis of historical trends. The analysis referred to the European Union to understand Romania's international regional context in order to highlight its position and performance vis-à-vis the rest of the Member States. It also sought to identify the current vulnerabilities and opportunities of the relationship between energy, emissions, and other components of the EU socio-ecological complex. Firstly, the EU 2020 targets for energy consumption cannot be considered to be sufficiently ambitious in the context of a lack of a 20% drop in each of the two indicators on consumption compared to 2005, but in fact represents a cumulation of the reduction in final energy consumption and primary energy consumption. In order to effectively reduce each type of energy consumption by 20%, the analysis has shown that the EU should have assumed its 953.4 Mtoe target to reduce final energy consumption to 1086 Mtoe as the current 2020 target and a target of 1370.2 Mtoe of primary energy consumption compared to 1483 Mtoe as the current 2020 target. For Romania, the 2020 target for CFE should be 19.7 Mtoe compared to 30.3 Mtoe at present, while for the CEP the 2020 target should be 29.3 Mtoe compared to the current target of 43 Mtoe. It has also been shown that energy consumption is generally lower after 2006, both at EU level and at the level of most Member States. According to the analysis, as well as to the European Commission Communication (2015c), it was demonstrated that EU's maximum energy consumption as a whole was reached in 2006; therefore, it should be considered as a basis for reporting energy savings. However, the same point cannot be highlighted in the case of Member States. For example, in the case of Romania, the maximum was reached in 1990, and, therefore, it should be considered as a basis for reporting.

In 2014, the EU has exceeded its target of reducing final energy consumption, but some Member States have failed to do so. In addition, under current and historical conditions, there is a possibility that at least four countries will not meet them by 2020, so their efforts will have to be multiplied. At the same time, the EU has not reached its target of reducing primary energy consumption, but it is expected to reach it by 2020 without further efforts. However, in this case there is also the possibility of non-compliance in attainment of the targets by at least three Member States. It was also found that the projections of Capros et al. (2016), which support the need for a 0.2%/year reduction in CFE and 0.8% per year for CEP, are only good to meet the 2020 final energy target, while the 2020 target for primary energy consumption can be achieved with a decrease of 0.4%/year, considering the reporting year in 2014. Although, overall, at the EU level, the 2020 energy savings targets can be met if historical and current conditions are maintained, there are states Member States that will not do so if actions to combat energy consumption increase do not intensify.

The EU and individual Member States should reconsider the targets for reducing energy consumption with the implementation of measures to promote the importance of energy efficiency and energy conservation among the population, focusing on civic involvement at the individual and organization. Also, a measure to stimulate energy efficiency may be to eliminate green electricity taxation over a period of time or, like the Swedish measure, to eliminate electricity taxation over a 5-year period for those companies that implement an energy management system and are subject to audit energy strategy, following which energy efficiency measures suggested by these assessments are adopted (European Commission 2015b). Another recommendation is to improve the situation of the external balance of services and goods, as well as to finance the health system which, according to the analysis of the third chapter, stimulates the reduction of energy consumption.

Secondly, EU interim targets for 2010 and 2015 on the share of renewable energies in total gross final consumption of energy have been reached and overcome without problems. However, meeting the 2020 and 2030 targets at both EU and Member State level is questioned. From projections based on historical developments after 2005, ceteris paribus, 7 countries out of 28 will face difficulties in meeting the 2020 target, requiring new solutions to drive renewable energy implementation and reconsider the effectiveness of policies and instruments used in the field. Finally, it was found that the European Union has adopted energy policies to reduce GHG emissions and to promote more energy-efficient green energy use over time. Perhaps after 2020, the EU adopts integrated ways to improve energy saving with increasing use of renewable energies by taking into account the issues arising in this research and by integrating the components of the socio-ecological complex without forgetting the stimulation of innovation and technical progress that would could harmonize the relationships between the socioeconomic system and the natural environment. It is recommended that Member States should be genuinely accountable for achieving more ambitious targets in relation to the absolute maximum value of each Member State's emissions in the past period by reconsidering current targets and reflecting on the findings of this research.

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Chapter 10
Sustainable Consumption Behavior Among Romanian Students

Rodica Ianole-Călin, Magdalena Rădulescu, and Elena Druică

Abstract The aim of this chapter is to assess the inclination toward sustainable consumption among Romanian students, using the young consumers' sustainable consumption behavior (YCSCB) scale pertaining for two dimensions, food and clothing, a scale developed by Daniel Fischer and his colleagues in 2017. We applied the questionnaire to a sample of 352 students from various Romanian universities and explored the association between their inclination toward sustainable food and clothing consumption, after controlling for age, gender, and residence. The importance of our work is multifold. First, to our knowledge, this is the first study addressing the problem of sustainable consumption in Romanian students. We claim that understanding the drivers of their consumption for areas like food and clothing can provide insights into their perceptions and awareness level on the sustainability issue and thus contribute to building up a more realistic approach of behavioral change. Last, but not least, we were able to compare the results with other studies conducted in different parts of the world. The limitation of our approach lies in the convenience sample based on which we conducted our study.

Keywords Sustainable consumption behavior · Sustainable food consumption · Sustainable clothing consumption · Factor analysis · Romania

10.1 Introduction

For more than a decade now, the sustainability concept has reached a buzzword stage (Scoones 2007) in terms of popularity and further progressed into being considered a megatrend (McDonagh and Prothero 2014). However, this is by no means the result of a consensus in the conceptual perimeter, especially taking into account the

R. Ianole-Călin (✉) · E. Druică
Faculty of Business and Administration, University of Bucharest, Bucharest, Romania
e-mail: ianole.rodica@gmail.com

M. Rădulescu
Department of Finance and Accounting, University of Pitesti, Pitesti, Romania

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multidisciplinary nature of sustainability. While sustainability in general is associated with a long-term economic liability and a good management of the limited natural resources (Lee et al. 2016), the mainstream discourse is occupied by sustainable development. There are numerous definitions for it (Glavič and Lukman 2007; Johnston et al. 2007), mostly pointing to the three dimensions in interaction – economic, environmental and social – and to sustainable consumption as part of the framework. More specific descriptors range from eco-efficiency requirements in production to green markets and a lower level of individual consumption (Mont and Plepys 2008). Closely related, the notion of green consumption also elicits various similar meanings, with a slight focus on green buying, either fair trade or organic (Gilg et al. 2005). Within this composite and dense literature, there is still an important attitude–behavior intention gap concerning the declarative side of achieving sustainable production and consumption versus the actual changes implemented to reach this objective (Vermeir and Verbeke 2006). Although consumers are aware of the importance of keeping the environment safe, they don't generally consume in a sustainable way (Francis and Davis 2015; Gadenne et al. 2011; Kolkailah et al. 2012; Leary et al. 2014; Liobikienė et al. 2014; Liu et al. 2012), and green consumers represent a small share of the total population (Gleim et al. 2013).From global to national perspectives, the current agenda in Romania revolves mostly on sustainable development as a general desiderate, with average results to show off (Moran et al. 2008), and very little on sustainable consumption. The lack of focus on individual behaviors opens up the research niche addressed by this chapter: arguing for the significant impact of individual consumption on unsustainable development (Thøgersen 2014), as well as acknowledging the intricacies of measurement for what may constitute a sustainable behavior in a certain area of life (Geiger et al. 2018).

Important streams of literature investigate either adult sustainable consumption behavior (mostly in relation with income levels) or teenager's sustainable consumption behavior, a period associated with a decreasing interest for the sustainability and environmental issues (Olsson and Gericke 2015; Stanes et al. 2015). With respect to the younger segments, many of the studies focused on revealing important disparities in regard to sustainable consumption behavior (Lee 2016; Perera et al. 2018; Hume 2010; Hitchings et al. 2013; Francis and Davis 2015; Brici et al. 2013; Xu 2008; Quoquab et al. 2013). Our aim is to strengthen this line of investigation by examining the behavior of the college student population in Romania. We believe this to be a more realistic inflection point for feasible intervention given that this is the stage when most of students obtain a higher degree of autonomy in making daily choices in terms of both expenses and potential independent incomes (given the high percentage of Romanian students working part or full time during their studies).To conduct our investigation regarding the individual behavior in terms of food and clothing, we choose an already validated instrument, the young consumers' sustainable consumption behavior (YCSCB) scale (Fischer et al. 2017). The main purpose of the study is to assess to what extent the results obtained from applying the YCSCB scale on a Romanian sample of students are comparable to those obtained on the German sample of teenagers. Secondly, we investigate the association between the two scales and the demographic profile, in an attempt to formulate a set of potential measures to enhance more sustainable behaviors.

10.2 Literature Review

Pro-environmental and sustainable attitudes are not often reflected into people behavior (Gupta and Ogden 2009; Kollmuss and Agyeman 2002; Pickett-Baker and Ozaki 2008). Habits, financial constraints, the loyalty to established brands, or lack of opportunities to practice pro-environmental behavior may have a negative effect on the pro-environmental consumption behavior (Peattie 2010). Knowledge is also considered an important predictor of green consumer behavior as it is assumed that consumers who are more aware and knowledgeable about environmental problems will be more motivated to practice green consumer behavior (Peattie 2010). However, sustainable consumption is not only about consuming differently, but it is also about consuming less for the sake of the next generations (Kostadinova 2016). Redman and Redman (2014) performed a survey of 346 teachers about sustainable food and waste, knowledge, and behaviors. The results supported the idea that high levels of declarative knowledge did not predict sustainable behaviors, while procedural and social knowledge were statistically significant predictors of sustainable food behaviors. Thus, structural and institutional changes are essential for encouraging sustainable consumption in young people. In a study performed for Lithuania, Jonkutė (2015) identified that the most important factors that influence consumers' choices were quality and convenience and comprehensive and understandable information on the products and their price. None of the survey participants completely denied the importance of sustainability, but only 58% of the survey respondents acted sustainably often (e.g., reuse of packing materials, conservation of the natural resources). This unsustainable consumption was explained by factors like limited financial resources, distrust of information about products and services, and a lack of political authority initiatives promoting sustainable consumption.

Moving the focus on young people, Bucic et al. (2012) analyzed their consumption behavior for Australia and Indonesia samples. Australians consider price, convenience, and packaging more important factors, while Indonesians focus on quality, brand, and convenience. Thus, ethical product attributes are not an active driver for their consumption decisions. For the case of Romania, the most recent relevant study was conducted by Lakatos and her colleagues (2018). The survey focused on evaluating the concern for the environment, ecologic activities, and sharing behavior, highlighting differences between generations. Their findings point out to the need of addressing young people consumption habits in a more specific manner, by comparison to the older generations. All these results signal a core issue and require further investigations, with a more precise delimitation on sustainable consumption and not consumption at large. In this vein, Lee et al. (2016) explored what sustainable consumption means for the young adults in Hong Kong and proposed a measure scale for a sustainable consumer behavior of the US students (Lee et al. 2016). Muralidharan and Xue (2016) analyzed the same behavior in India and China, with comparative studies revealing that the millennial's concern for green consumption is lower in India than in the USA (Muralidharan et al. 2016). There are various other associated measurement instruments, ranging from green consumption behaviors (Tanner and Wölfing Kast 2003; Gilg et al. 2005) or for the socially responsible or ethical consumption behaviors, including socioeconomic aspects such as fair working conditions (Pepper et al. 2009; Balderjahn et al. 2013). More empirical research can be traced for the former concept, green consumption, with extensive studies like the one of Paço et al. (2014) for a sample of 1175 university students in four countries (Portugal, Spain, the UK, and Germany). The results showed that the Straughan and Roberts' scale of green buyer's behavior is viable, stressing the relations between values, attitudes, and behaviors, as suggested by several authors (Straughan and Roberts 1999; Lee 2009 for Hong-Kong; Kim et al. 2012 for Korea).

Based on the model of a sustainable consumption behavior presented by Geiger et al. (2018), Fischer et al. (2017) developed a scale for measuring the consumption behavior of the German young people leaving with their parents in the area of food and clothing. The validated instrument, through qualitative and quantitative studies, offers a more pragmatic view of young people's behavior since it translates into two important dimensions of their lives and minimizes the biases induced by asking participants to imagine themselves into hypothetical or too complex situations.

10.3 Data and Method

10.3.1 Data

Assessing a sustainable consumption behavior in an objective manner is a strong empirical challenge given the multitude of behaviors among which to choose for creating a relevant proxy. Using as a reference point the integrative framework proposed by Geiger et al. (2018), namely, the sustainable consumption cube (SCC), the chosen scales (Fischer et al. 2017) are focused on one of the three dimensions labeled "consumption area." This category is split into food, housing, mobility, and clothing, among which we consider food and clothing as the most relevant for our target population.

Our Romanian version of the sustainable food consumption (SFC) scale was comprised of the original 17 items translated (2 control questions and 15 items), and the sustainable clothing consumption (SCC) included 21 items derived from the original set of 16 (inclusive also of 2 control questions). Given the translated meaning in Romanian, we decided to split the item "I wear patched and mended clothing" into two different items: "I wear patched clothing" and "I wear mended clothing." Similarly, we split the item "I choose high quality and long lasting clothing items" into "I choose high quality clothing items" and "I choose long lasting clothing items." We have also added three extra items: "I use to keep, in a useless way, clothing that I don't wear anymore," "I prefer quality clothes to modern clothes," and "I prefer durable clothes to modern clothes." A convenience sample was recruited in the month of April 2016, through our academic network in six Romanian university centers (Bucharest, Constanta, Timisoara, Galati, Pitesti, and Iasi) and also via social media. From the initial 388 participants, 36 entries were eliminated due to incomplete answers or extreme values regarding the average student age. The data collection process was carried out through an online survey, and participation in the study was voluntary and anonymous. The final sample was composed of 352 Romanian students, with an age between 18 and 25 years (average 21.08 years, standard deviation 1.5). The gender distribution follows fairly the existing proportion for social science studies, with 79.8% females and 20.2% males. Also, 38.4% of the participants were originally from a rural environment and 61.6% from an urban environment.

10.3.2 Method

We use factor analysis to explore the factorial structure of the scales. In the first stage, we explore the correlations between items within each scale, measure the internal consistency, and remove items that are found to measure different dimensions than the rest of the items. After setting the final versions of the scales, we check the appropriateness of factor analysis using the Kaiser–Meyer–Olkin statistic and proceed with exploratory and confirmatory factor analysis. We present some of the goodness of fit measures and discuss the results in terms of construct validity for each of the reduced scales.

10.4 Results and Discussions

The answers to the control questions illustrate the relevance of the analyzed behaviors for students. For the food case, few (0.56%) said they never bought food or prepared a meal (5.9%), with more than 80% buying frequently and roughly 50% preparing it also on a regular basis. For the clothing case, almost 90% of the participants state that they buy clothes by themselves, and low percentages are obtained for the second statement – "I receive clothes as gifts." This item is slightly rephrased from the original one – "I don't have to pay for my clothes" – giving the increased autonomy of our student population, by comparison with teenagers. We conducted a Kolmogorov–Smirnov test and found that there are significant differences between the distributions of the answers involving buying clothes, compared to buying food. A similar relationship between the mean obtained for buying food and that obtained for buying clothes mirrors the original study of Fischer et al. (2017), for the German sample of teenagers: Romanian students buy more clothes (average 4.6) than food (average 4.4) for themselves. We admit that the distributions of the two variables are highly skewed, and therefore mean is not a relevant description of the entire data, but since the median is 5 in both cases, a higher mean for buying clothes is an indication to higher scores compared to buying food.

10.4.1 The Sustainable Food Consumption (SFC) Scale

The internal consistency of the initial sustainable food consumption (SFC) scale is rather low, with a Cronbach's alpha of 0.53 (descriptive statistics are presented in Appendix Table 1). Some of the variables are highly skewed, for example, C1, C2, or C9, making their inclusion in a factor analysis not only irrelevant but also a source of estimation bias. C1 and C2 describe consumption habits and are highly concentrated toward the upper side of the scale, providing an indication that the participants in the study eat meat and dairy products on a regular basis. By contrast, C9 is concentrated toward the lowest values of the scale and signals that the majority of students do not buy products right before their expiration date, even if, under normal circumstances, we would consider this an efficient approach. Figure (10.1) presents the correlations among the variables involved in SFC and clearly shows that many items need to be dropped in an attempt to find a factorial structure of the scale.

The new scale consists of seven items (Table 10.1), with an acceptable level of internal consistency. The Bartlett's test of sphericity confirms that looking for significant correlations within variables makes sense, while the decent value of the Kaiser–Meyer–Olkin statistic (0.73) indicates that factor analysis is appropriate to analyze our data. Dropping any of the remained items cannot further increase the internal consistency of this reduced scale.

It is the intuition provided by the visual presentation of the scale (Fig. 10.1) that suggests that the remaining scale is not only one-dimensional but also a parallel analysis. Figure (10.2) shows that only one factor has an eigenvalue higher than 1, with the loadings of each variable in this factor presented in Table (10.3).

The poor consistency of the scale becomes evident once again in Table (10.2); the items which remained in the reduced SFC cover a broad range of concerns, capturing many aspects that normally would be assigned to different dimensions. One possible explanation is the low level of preoccupation regarding the sustainability of food consumption, making students behave in relation to the plain need for food, and not in response to a specific and more profound motivation in choosing food.

Another possible explanation that goes hand in hand with the previous one is that some of the answers are in line with socially desirable behaviors or clichés, for example, keeping a healthy diet, buying fare trade products, or supporting local farmers, and not with students' awareness regarding the issue as such. A good argument in line with our assumption is that SFC 7 and SFC 13, which would signal a type of awareness regarding the sustainable dimension of food consumption, have loadings below 0.4, a cutoff preferred in many research papers. Given our large sample size, we accepted these items as relevant for the scale, but still their low loadings raise a question mark regarding the algorithm (rationality, awareness versus

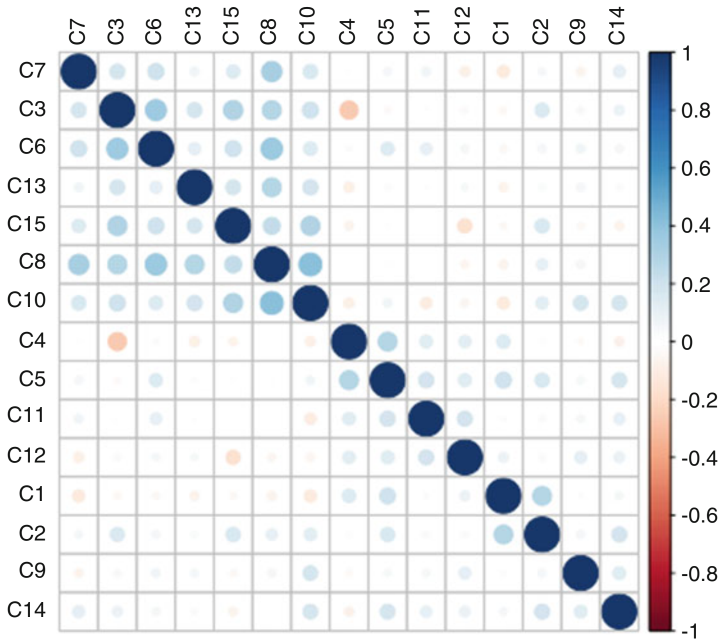

Fig. 10.1 The intensity of the correlations among items in SFC

Table 10.1 Reduced Romanian SFC

Reduced Romanian SFC scale, $\alpha = \mathbf{0.68}$
3. I keep a healthy diet
6. I buy organic food products
7. I avoid food products in excessive packaging
8. I buy fair trade food products (e.g., with a fair trade label)
10.I buy locally grown food products
13.I cook/prepare my meals energy-efficiently
15.I use fresh ingredients for meal preparations

simple heuristics developed in response to repeated exposure to social clichés) that drove the students' answers. This one factor detected in the reduced SFC explains only 24.6% of the entire variation in data, with high uniqueness being found for each of the items as presented in Table (10.3).

In terms of confirmatory factor analysis, we found that the performance of the model express through the goodness of fit values presented in Table (10.4) is pretty decent, considering the lack of similar content displayed by the remained items.

To summarize, the SFC scale applied to this sample does not reveal any of the dimensions revealed in the original study, and we have reasons to admit that much of the consistency of the reduced SFC comes from clichés and socially desirable answers, rather from students' awareness regarding their food consumption behavior.

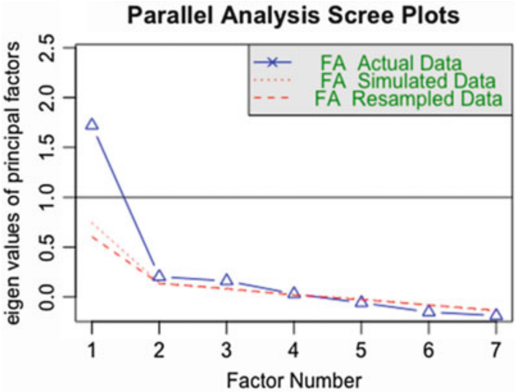

Fig. 10.2 The scree plot for the reduced version of SFC

Table 10.2 Factor loadings for the reduced SFC

	Item	Factor 1 – food choice
SFC 3	I keep a healthy diet	0.486
SFC 6	I buy organic food products	0.492
SFC 7	I avoid food products in excessive packaging	0.394
SFC 8	I buy fair trade food products (e.g., with a fair trade label)	0.720
SFC 10	I buy locally grown food products	0.515
SFC 13	I cook/prepare my meals energy-efficiently	0.352
SFC 15	I use fresh ingredients for meal preparations	0.424

Table 10.3 Uniqueness for each item in the reduced SFC

	Item	Uniqueness
SFC 3	I keep a healthy diet	0.764
SFC 6	I buy organic food products	0.758
SFC 7	I avoid food products in excessive packaging	0.845
SFC 8	I buy fair trade food products (e.g., with a fair trade label)	0.481
SFC 10	I buy locally grown food products	0.735
SFC 13	I cook/prepare my meals energy-efficiently	0.876
SFC 15	I use fresh ingredients for meal preparations	0.821

10.4.2 The Sustainable Clothing Consumption Scale

The internal consistency of the sustainable clothing scale (SCC) is moderately good from the beginning, with a Cronbach-Alpha of 0.7, with little room for improving to 0.71 by dropping item 7 (descriptive statistics are presented in Appendix Table 2). The lowest mean values of all items appear, in order, for items 6, 5, and 13. The strong dissociation from these behaviors is probably linked to several characteristics of our students that may regard: their need for control and ownership (item 5), the

Table 10.4 Goodness of fit measures for the CFA with 1 factor (reduced SFC)

Fit indices	Recommended values	Romanian SCC
Comparative Fit Index (CFI)	≥ 0.95	0,901
Root Mean Square Error of Approximation (RMSEA)	<0.05	0.078
Tucker-Lewis Index (TLI)	>0.9	0, 852
Standardized Root Mean Square Residual (SRMR)	<0.08	0,049

risk of signaling an undesirable social status (item 13), or simply their perception that doing clothes for themselves involves too much effort, or yields little reward. Figure (10.3) displays the correlations among items in the initial version of the scale, showing several patterns with moderate correlations. Based on the graphical presentation, we expect two to three factors, with one extra factor including some items with negative correlations (H2 and H3). This number of factors is supported by the parallel analysis illustrated in Fig. 10.4, where any number between 2 and 5 could be a feasible choice.

We explored different options and found that the best fit corresponds to the four factors presented in Table (10.5). An aspect to be noticed is that in our explorations, we found that Factor 1 remains unchanged regardless of the total number of factors (2, 3, or 4) involved in our exploratory analysis.

The factors illustrated in Table 10.5 explain 35.3% of the overall variance in data, which is not a good performance, but still the goodness of fit measures presented in Table 10.6 is pretty good. The uniqueness values are also high for this scale, showing that despite the decent values recorded for individual loadings, each observable item in the scale is highly influenced by other variables that are not captured by the factors. In two cases, high values of uniqueness correspond to the dropped items, for example, SCC5 (0.894), SCC6 (0.895), and SCC7 (0.984). SCC4, despite its high uniqueness (0.905), still loads in Factor 2 but with a loading below 0.4. The final scale derived after dropping irrelevant items is presented in Table (10.5).

The Cronbach's alpha value for each dimension, as presented on the second line in Table (10.5), shows that the first and the fourth have a very good internal consistency, while the second and the third are less reliable. This internal consistency cannot be further improved by dropping other items. In terms of factor meaning, the most stable factor across explorations, Factor 1, stands for the durability and quality of clothes, all four items eliciting loadings over 0.6. The second factor includes items that refer to clothes production; the only item that is not coherent with the rest of the items in this factor is SC4. However, as mentioned before, this item has a high uniqueness, and its loading in this factor is below the often accepted cutoff of 0.4. The third and fourth factor, including items with loadings over 0.5, stand for different dimensions of sustainability, related to wasting on the one side and extending clothe lifecycle through mending, patching, and alternative usage on the other side. Different patterns are observed also in the case of SCC, by comparison to the German sample, for which the scale unfolds in only two-factors: sufficiency/

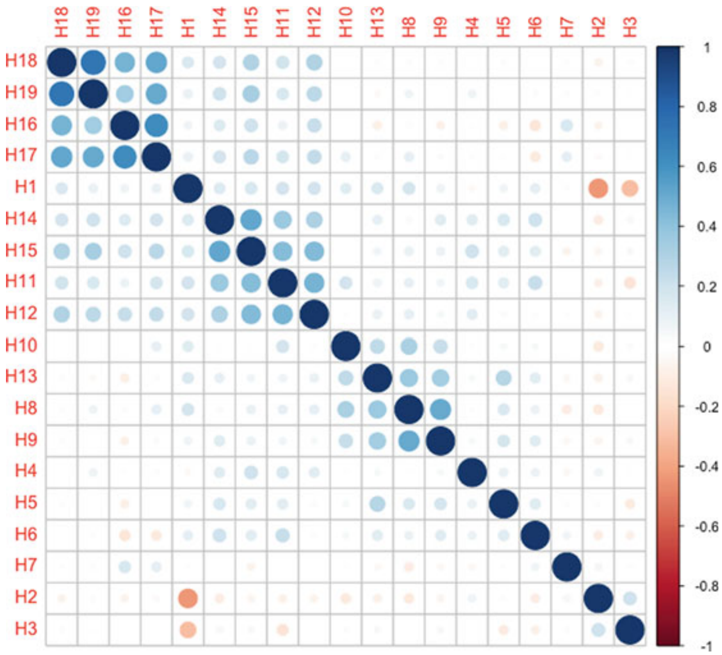

Fig. 10.3 The intensity of the correlations among items in SCC

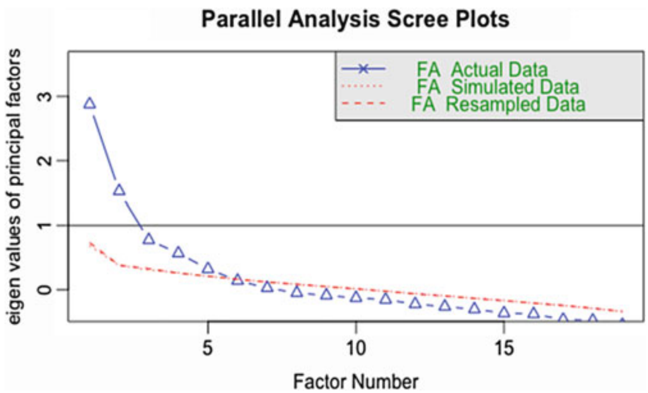

Fig. 10.4 The scree plot for the SCC

frugality consumption and purchase choices. Technically, the four-factor model yields a satisfactory fit, as it can be seen in the indices presented in Table (10.6).

The higher variability for the Romanian students suggests a more heterogeneous set of social and symbolic representations surrounding clothing. We fit a final structural equation model that explores simple associations between the two sustainable consumption scales – food consumption and clothing. Table (10.7) presents

Table 10.5 Factor loadings – four factors in SCC

Item	F1	F2	F3	F4
Cronbach's alpha by dimension	0.82	0.68	0.67	0.81
SCC1. I give away or swap unwanted clothing items that I no longer wear				0.775
SCC2. I throw away clothing items that I no longer wear				−0.557
SCC3. I keep, uselessly, cloths that I don't wear anymore				−0.415
SCC4. I air my clothing items properly before deciding whether they need washing		0.326		
SCC8. I don't mind to wear patched clothing			0.762	
SCC9. I don't mind to wear mended clothing			0.678	
SCC10. I look for other possible uses of unwanted clothing items			0.399	
SCC11. I choose clothing items from fair trade production		0.612		
SCC12. I choose clothing items from organic production (e.g., made from organic cotton)		0.503		
SCC13. I buy secondhand clothing			0.513	
SCC14. I avoid buying clothing items that originate in countries with poor working conditions		0.655		
SCC15. I choose clothing items with labels that guarantee absence of chemical pollutants		0.733		
SCC16. I choose high-quality clothing items	0.601			
SCC17. I choose long-lasting clothing items	0.682			
SCC18. I prefer quality clothing to modern clothing	0.816			
SCC19. I prefer long-lasting clothing to modern clothing	0.755			

Table 10.6 Goodness of fit measures for the CFA with four factors (SCC)

Fit indices	Recommended values	Romanian SCC
Comparative Fit Index (CFI)	≥ 0.95	0,911
Root Mean Square Error of Approximation (RMSEA)	<0.05	0.058
Tucker-Lewis Index (TLI)	>0.9	0,891
Standardized Root Mean Square Residual (SRMR)	<0.08	0,048

the estimated coefficients along with their standard errors, derived based on a bootstrapping procedure with 1500 repetitions.

The results presented in Table 10.7 show that the one-dimensional SFC scale has a positive and significant positive association with Factor 1, clothing durability and quality; Factor 2, clothing production; and Factor 4, decisions regarding unused clothing. The association between the SFC scores and the third SCC factor is only marginally significant, a result that makes sense considering the fact that Factor 3 pertains for clothing characteristics that do not have any correspondent in food consumption. Most likely, specific features that are not part of the model, for example, social norms, group influences, or other variables that deserve further exploration, mediate the association between the SCC dimensions and SFC scores

Table 10.7 Associations between scales

Independent variables	SCC Factor 1	SCC Factor 2	SCC Factor 3	SCC Factor 4
SFC scores	0.530***	0.531**	0.362	0.718***
	(0.163)	(0.174)	(0.217)	(0.224)
Age	−0.002	−0.004	−0.023	−0.049
	(0.020)	(0.011)	(0.040)	(0.044)
Gender – male	−0.103	−0.02	−0.172	−0.586***
	(0.073)	(0.038)	(0.149)	(0.178)
Residence – urban	0.112	−0.051	0.020	−0.031
	(0.071)	(0.035)	(0.136)	(0.133)
Observations	352	352	352	352
R-squared	18.6%	59.9%	2.9%	10.8%

Robust standard errors in parentheses
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

pointing to an overall attitude toward sustainability. Age is not significant for either factor, which is not surprising given the homogenous segment 18–25 years, while gender appears negatively correlated with factor 4: males have a lower score than females in the area of dealing with unused/unwanted clothing.

10.5 Conclusions and Further Research

The paper presents a replication study of the young consumers' sustainable consumption behavior (YCSCB) scale, implemented on a Romanian student sample. It provides a valuable contribution both by enriching the range of the instrument outside its primary application, as well as by introducing in Romania the focus on behavior and not simply on attitudes and intentions with respect to sustainability. The psychometric properties of the two subscales – sustainable food consumption and sustainable clothing consumption – reveal the need for a reduced form in both cases, leading to a 7-item SFC and a 16-item SCC. The larger number of factors indicated in both cases, by comparison to the two-dimensional structures characterized the German sample, can be interpreted as a need for further qualitative research for gaining a better understanding on the mental representations associated to sustainability. Nonetheless, the positive correlation between the subscales stands a good proof of internal consistency of the theoretical model of the sustainable consumption cube, with some important gender differences. This is in line with evidence from the literature suggesting that young female adolescents have a higher score for pro-environmental attitude and consumption behavior than males in Hong Kong (Lee 2009) or that, in general, women are more active in environmental issues than men (Zelezny et al. 2000). Beyond the main technical implication of further refining and adapting the measurement instrument for a society where the level of the mainstream discourse has just started to integrate aspects of clothing production conditions or more positivity associated with personal recycling and reusing objects and materials, the current research also stands as reference point in terms of evaluating the current state in order to reinforce the need to implement more behavioral economics approaches for behavior change. In order to increase both awareness and scale scores for specific sustainable behavior, we may simply increase exposure to sustainable or green ideas and products, benefits from the fruits of priming mechanism (Mazar and Zhong 2010). Or, following a more pragmatic and field-experiment framework, we can rely on the findings of Demarque et al. (2015) that show how to promote sustainable consumption in shopping environments by the mere use of descriptive norms. These alternative research methods also serve to acknowledge the current limitations of the paper, starting from the convenience sample that needs extensions to properly represent the student population in Romania. Moreover, the range of control variables would benefit from supplementary measures, like income, habits, and social influence, but also objective environmental knowledge.

Appendices

Appendix Table 1: Descriptive Statistics for SFC Items and Internal Consistency

SFC scale, $\alpha = 0.53$	Mean	Standard deviation	Range
1. I eat meat (steak, ham, etc.)	2.14	1.08	1–5
2. I eat dairy products (butter, cheese, yogurt, etc.)	3.78	1.08	1–5
3. I keep a healthy diet	3.25	0.93	1–5
4. It happens that I discard food products	2.79	1.18	1–5
5. I buy snacks and beverages in disposable packaging (take away, fast food, coffee to go, etc.)	3.28	1.13	1–5
6. I buy organic food products	2.50	1.02	1–5
7. I avoid food products in excessive packaging	2.92	1.08	1–5
8. I buy fair trade food products (e.g., with a fair trade label)	2.80	1.08	1–5
9. I buy food products even just before the best before date expires	1.84	1.09	1–5
10. I buy locally grown food products	3.17	1.07	1–5
11. I buy fresh fruits and vegetables from overseas (e.g., mangos, avocados)	2.90	1.08	1–5
12. I use frozen foods for meal preparations	3.55	1.11	1–5
13. I cook/prepare my meals energy-efficiently	2.94	1.04	1–5
14. I reuse leftovers for the next meal	3.27	1.29	1–5
15. I use fresh ingredients for meal preparations	4.10	0.83	1–5
SFC average	3.02	0.39	1–5

With 1, 4, and 12 as reversed items

Appendix Table 2: Descriptive Aspects of the SCC Original Scale

SCC scale, $\alpha = 0.7$	Mean	Standard deviation	Range
1. I give away or swap unwanted clothing items that I no longer wear	3.79	1.25	1–5
2. I throw away clothing items that I no longer wear	4.12	1.08	1–5
3. I keep, uselessly, cloths that I don't wear anymore	3.05	1.37	1–5
4. I air my clothing items properly before deciding whether they need washing	2.54	1.32	1–5
5. Instead of buying a new piece of clothing for a special occasion, I borrow something	1.6	0.9	1–5
6. I make clothing items myself (e.g., sewing, knitting)	1.45	0.89	1–5
7. I sort out clothing items that are no longer fashionable or do not match my taste anymore	2.80	1.29	1–5
8. I don't mind to wear patched clothing	3.32	1.29	1–5
9. I don't mind to wear mended clothing	2.20	1.30	1–5
10. I look for other possible uses of unwanted clothing items (e.g., as a cleaning cloth or recycling projects)	3.70	1.29	1–5
11. I choose clothing items from fair trade production	2.51	1.12	1–5
12. I choose clothing items from organic production (e.g., made from organic cotton)	2.94	1.25	1–5
13. I buy secondhand clothing	2.10	1.27	1–5
14. I avoid buying clothing items that originate in countries with poor working conditions	2.28	1.06	1–5
15. I choose clothing items with labels that guarantee absence of chemical pollutants (e.g., OEKO-TEX® confidence in textiles)	2.40	1.14	1–5
16. I choose high-quality clothing items	4.20	0.92	1–5
17. I choose long-lasting clothing items	4.20	0.86	1–5
18. I prefer quality clothing to modern clothing	3.89	1.02	1–5
19. I prefer long-lasting clothing to modern clothing	3.78	0.99	1–5
SCC average	2.99	0.45	1–5

With 2 and 3 as reversed items

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Chapter 11
Deforestation in Malaysia: The Current Practice and the Way Forward

Abdelnaser Omran and Odile Schwarz-Herion

Abstract Among global climate concerns, deforestation is one of the most critical, particularly in developing countries but also in industrial countries where forests are equally rhoded to make place for windmills and 5G masts in an attempt to satisfy the energy need and the requirements for fast data transfer in highly digitalized Smart Cities. Deforestation is an activity of permanent destruction—the clearing of earth's forests on a massive scale, damaging huge land areas by removing indispensable sinks for CO_2, destroying complex eco-systems, and causing a significant loss of biodiversity. In recent years, several efforts have been introduced and implemented to reduce deforestation, but appears such efforts are on the decline in some countries, including Malaysia. This chapter examines the factors that contribute to deforestation as based on the perception and understanding of residents from across Malaysia. A survey questionnaire of 59 respondents, randomly distributed among Malaysians in different parts of the country, indicate a majority of the participants believe urbanization is the main contributor to deforestation, with 56% of east Malaysia respondents and 40% of west Malaysia saying so. However, those conducting the survey concluded that palm oil plantation is, in fact, perceived as the principal cause of deforestation, since its weighted average was highest. —In fact, Malaysia is one of the biggest exporters for palm oil. The study also concluded that deforestation can be successfully reduced by numerous methods, including vertical housing—the building of structures on narrower plots of land than conventional houses.

Keywords Deforestation · Agriculture · Mining · Logging · Urbanization · Malaysia · Carbon dioxide sinks

A. Omran (✉)
Faculty of Engineering Sciences, Bright Star University, El-brega, Libya
e-mail: naser_elamroni@yahoo.co.uk

O. Schwarz-Herion
Dres. Schwarz-Herion KG Detective Agency, Ettlingen, Baden-Württemberg, Germany

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11.1 Introduction

Deforestation converts forest land to alternative, permanent, non-forested land to be used in agriculture, grazing or urban development (Van Kooten and Bulte 2000). Aliyu et al. (2014) stated that deforestation can be defined as the clearing of any area of its natural vegetation cover, which normally leads to a decrease in plant population, resulting in a loss of plant biodiversity. According to Indarto and Mutaqin (2016), deforestation is a major issue discussed in global climate investigations. Deforestation can lead to two important environmental challenges, namely, loss of biodiversity and rising greenhouse gas emissions due to the removal of trees as efficient natural CO_2 *sinks*. Forests are natural climate protectors by providing timber as a renewable resource and by binding CO_2, thus acting as natural *carbon dioxide sinks* (Bundeswaldinventur 2015). Having nearly 350 million years of experience with sequestering carbon, trees convert CO_2 and H_2O into cellulose, sugar and other carbon-containing carbohydrates via *photosynthesis*. In sum, forests are storing carbon at a greater rate than releasing it (Department of Environmental Conservation 2018). Metaphorically speaking, forests are the "lungs of the planet. . .allowing the planet to 'breathe'" (Bouchard 2018) by an exchange between CO_2 and O_2 occurring in the leaves of the trees (Bouchard 2018). Meanwhile, Mather and Needle (1998) summarized deforestation thus:

> The study of the casuality of trends in forest cover. . .does not readily yield the simplicity and elegance of explanation that would reward the ideal scientific endeavor. In the real world of human-driven change in land and land cover ... numerous problems and difficulties ... confound such an endeavor. The field cannot be successfully tilled as a disciplinary preserve, and neither reductionism nor holism alone seems to offer the approach necessary for success. [117–124]

According to Becek and Odihi (2008), human activities are globally recognized as the principal cause of deforestation. Deforestation is defined by FAO (2001) as the direct, human-induced conversion of forested land to non-forested land; presumably carried out for the permanent conversion (loss) of the forested area. Non-forested land that has been converted has subsequently been used for agriculture, logging, fuel, burning, grazing and improper forest management (Allen and Barnes 1985). Moreover, companies make use of the resources from the forest to produce tradable consumption goods, such as timber for planks and pulp (paper), goods that later are traded domestically and internationally through export. Commodities traded include palm oil (used principally for foods and cosmetics), pulp and timber. The raw materials are mainly supplied by developing countries, as export commodities are the main backbone of their economy (CFC 2005). Thus, deforestation has been one method for boosting income from exporting commodity goods in developing countries, which triggered the rate of deforestation to be higher compared to most developed countries. In a study conducted by Wicke et al. (2011), in Malaysia alone, there has been a 20% reduction in forest land, while Indonesia has seen a 30% reduction in a 30-year span. The fact that these countries are principal suppliers for 85% of world palm oil demand implies that palm oil plantation are among the major triggers of deforestation (Wicke et al. 2011).

One particular area, Borneo Island (which is shared by three Southeast Asian countries, Brunei, Malaysia and Indonesia) has endured major deforestation, losing 50% of its lowland rainforest, mainly to massive deforestation for palm oil plantations (Shoumatoff 2017). Despite the massive land claim, Malaysia respondents stated that the country's total forested area decreased by only 0.49 mil ha (from 18.78 to 18.27) from 1990 to 2014 (NRE 2016). Illegal deforestation has also been addressed by both governments (Indonesia and Malaysia) in Borneo, although in a survey, respondents from Malaysia stated there had been an improvement in the illegal deforestation situation (Lawson and MacFaul 2010). This improvement, due to regulations put into effect by the Malaysian government, indicates deforestation is not taken lightly by the government. However, several parties including Borneo locals, international organizations and ecological experts have stated their dissatisfaction regarding the government's handling of the issue. Many believed the lack of transparency was a factor in the ineffective eradication of illegal logging, which worsened the deforestation crisis. The public urged both palm oil plantation owners and the government to take steps to manage risk. The most popular opinions promoted sustainable plantation and reforestation (Aguilar et al. 2007), to minimize ecological damage. However, as soil needs time to reclaim its natural nutrients, reforestation takes quite a while. Several alternative options for fuels, oils and timber were also put forth as ways to lessen a world consumption of these commodities, all of which contribute to the loss of rainforest. However, such alternative options often cost more than that which can be gained from Malaysia's forest.

11.2 Problem Statement

Southeast Asia is known for its vast rainforests, which constitute about almost 20% of forest cover with the richest biodiversity in the world (Victor 2017). Most concentrated deforestation occurs in tropical rainforests (Bradford 2018). Malaysia is one of the countries with the fastest disappearing forests due to deforestation; this

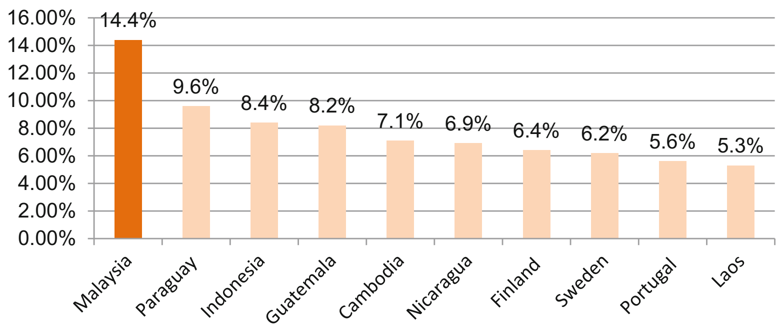

Fig. 11.1 Major forest countries which faced highest percentage forest loss between 2000–2012. (Source: Butler 2013)

is now a huge problem, as most of the recent disasters such as mudslides and floods happened and are happening with greater frequency due to deforestation. Geologist Felix Tungkol, from Universiti Malaysia Sabah, has pointed to deforestation as the possible, primary cause of the country's devastating mudslide of April 2017 (John 2017). According to a new global forest map developed in partnership with Google, Malaysia had the world's highest rate of forest loss between 2000 and 2012 (See Fig. 11.1). The total forest loss in Malaysia during that period amounted to 14.4% of its year 2000 forest cover (Butler 2013). The loss translated to 47,278 square kilometers (18,244 square miles), an area larger than Denmark (Butler 2013).

Although the EU itself is the world's second-largest importer of palm oil and has subsidized it since a long time already, the European Commission has officially accused oil palm plantations of being the main culprit behind deforestation and climate change (Transportenvironment.org 2019; Ellis-Petersen 2018), but inconsistenly still continues to subsidize oil palm cultivation and the resulting deforestation (Transportenvironment.org 2019); meanwhile Marcus Mojigoh, vice-president of the Asia-Pacific Parliamentarians' Conference on Environment and Development (APPCED) admitted that palm oil plantations caused Sarawak natives to be deprived from native lands on Borneo Island (Patrick 2017). Reports regarding climate change and even the dangers of primate extinction in Malaysia led to a possible ban of palm oil imports from Malaysia to the EU. Numerous campaigns that inform consumers about the dangers of unsustainable deforestation surrounding palm oil plantation activities have been put in the spotlight by major international nonprofit charitable organizations such as World Wildlife Fund (WWF) and People for the Ethical Treatment of Animals (PETA) (BBC 2018). The independent campaigns focus on keeping consumers from eating products with palm oil as a main ingredient, such as Nutella from Ferrero (which sources its palm oil from Malaysia), claiming that besides the unsustainability of the industry, palm oil also results in bad health outcomes like cancer, a claim that the company later denied, drawing on tests by the European Food Safety Agency (EFSA) and by the Malaysian Palm Oil Board (MPOB) (Sundram 2017). The EU ban itself may cause Malaysia to lose RM10 billion revenues from export activities, or 15% of its total exports (Patrick 2017). Besides how Malaysia suffered in the area of international trade of palm oil, it also endured several landslide disasters in recent years due to deforestation. As is known, deforestation is the catalyst of erosion in lands with steep contours (slopes of more than 20%); without vegetation (trees) to apply pressure, the area is prone to landslides (Abidin 2016). The Sabah (Borneo) mudslide in 2017 and the Sarawak landslide in 2009 are actual cases of deforestation-caused landslides (John 2017; Felsinger 2009). With disasters arising from the condition of the land, comes climate change, which also figures into the picture of massive deforestation (UNFCC 2001). Greenhouse gases from industrial activities cannot be absorbed adequately due to deforestation, which leads to rising temperatures (Sinha and Swaminathan 1991). In general, temperature increases may affect a community as air quality drops; and, as the rainforest, which absorbs carbon dioxide and produces oxygen, shrinks. Although this issue cannot be directly measured in terms of monetary value, in the long term, it will affect sustainability of any business that depends on the existence of the rainforest (palm oil, mining and timber) and the living condition of residents, not only locals but also worldwide, since climate change is a global phenomenon. Thus, the chapter's main aim is to find out the causes and effects of deforestation in Malaysia.

11.3 Literature Review

11.3.1 Deforestation

Forests play a role in maintaining the sustainability of life on earth by providing abundant benefits for humans and by being an essential habitat in the ecosystem (WWF 2017). In addition, the biological diversity of two-thirds of terrestrial species is incorporated in forests, and almost 30% of the surface of earth is covered by forests (WWF 2017). From this perspective, the role of the forest is important in regulating the temperature of the world as well as producing freshwater flows (Ellison et al. 2017). Water availability and its cooling function is also underlined in the paper (Ellison et al. 2012; Hesslerová et al. 2013; Syktus and McAlpine 2016). The ability of trees to capture and redistribute the sun's energy is how they deliver a cooling function (Pokorný et al. 2010), and they have an infiltration capacity, which occurs in the soil after a rainfall; under appropriate conditions this capacity can improve groundwater recharge (Calder 2005; Neary et al. 2009). However, forested regions have diminished over time (Pongratz et al. 2010); despite environmental awareness and activism, the area of destruction of tropical rainforests is escalating worldwide, one factor being deforestation (Chakravarty et al. 2012). The term 'deforestation' means alternative permanent conversion of forest land into non-forested area or removal of forested area on a massive scale without replantation (Bradford 2018). The alternative land is used for urban development, agriculture or grazing (Van Kooten & Bulte 2000). NASA (2007) states that in deforestation : "oftentimes there are multiple processes that work simultaneously, rarely . . .caused by a single direct cause, for instance, after [a] logging activity [has] been conducted, the road building for a road expansion followed this activity". The destruction of forests has been ongoing from human activities, with various proximate causes such as large-scale commercial oil palm plantations, agribusiness, industrial logging (Yong et al. 2014). It adversely affects particular geographic areas that lack a wood supply for fuel and water resources (Barnes 1985). The result is decreasing greenhouse gas absorption, which increases the severity of global warming, drying out soils easily, and damaging land quality (Radachowsky 2018). A specific geographical area can be affected by deforestation (Barnes 1985); however, this chapter is concerned mostly with deforestation in the tropics, located mostly in developing countries (Myers 1994) where tropical forest area has shrunk (Barraclough and Ghimire 2000). Assessment of how forests changed over time was monitored using a balance between forest gain and loss, denoted with "tree canopy cover" in certain geographic regions (Chazdon 2014).

11.3.2 Palm Oil

The palm oil industry was criticized due its harmful impact on the environment, particularly on lowland tropical rainforest. The biggest cause of deforestation in Southeast Asia is linked to expansion of palm oil plantations, which threatened animal habitat (Klara 2011) and triggered biodiversity loss (Wilcove and Koh 2010). In a recent study, it was found that monoculture oil palm plantations converted natural forest, thereby decreasing overall diversity of plant and animal species, which count on the natural forest for their existence (Aratrakorn et al. 2006; Maddox 2007; Carlson et al. 2012). Research conducted by (Vijay et al. 2016) analyzed trends of total planted palm oil area from 1989–2013 in distinct regions; only Southeast Asia (Indonesia and Malaysia) deforestation patterns with skewed perspective occurred, but, in the future this might be continual. Furthermore, based on data, Southeast Asia is rapidly expanding in oil palm planted areas, and expansion has occurred in other regions. For Malaysia, 39% of vulnerable forest saw deforestation and conversion to palm oil plantation. Palm plantation as the main direct cause of deforestation was hard to quantify, since there was land-cover change was lacking, as were subnational patterns, incomplete understanding of the complex causes and a changing definition of forest (Fitzherbert et al. 2008). Another study categorized the palm oil plant as forest and therefore not a contributor to deforestation (Sheil et al. 2009). Moreover, half of all palm oil expansion comes at the expense of primary and secondary forest while the rest is owed to the previous conversion of cropland (into rubber plantations, for instance). Klara (2011) showed a large portion of Malaysian deforestation was a result of oil palm expansion in 1990 and 2007.

11.3.3 Primate Extinction

Deforestation has another negative impact: As stated by Whitmore and Sayer (1992), species extinction might depend on the distribution of the species in the area of the forest and on disturbances such as change in biomass and structures. Every country has reserve forest land on which the number of species in the region can be studied. Establishment of a reserve area protects species from extinction. Ecosystem fragmentation, normally the result of human disturbances like deforestation, has caused species extinction. Changes in forest landscapes impact animal life and biodiversity (Turner 1996).

11.3.4 Importance of Sustainable Plantations

In Malaysia, the Roundtable on Sustainable Palm Oil (RSPO) includes oil palm growers, retailing outlets and NGOs, who participate in solving issues and setting up basic practices for sustainable palm oil production. According to Nikoloyuk et al.

(2010), this association certifies those plantation companies who set aside areas for preservation. One of the interesting principles established by the association is that primary forest and conserved areas should not be cleared for palm oil plantation. It also respects the rights of landlords and farmers. Sime Darby is an outstanding example in the practice of sustainable plantation; it maintains natural forests with estates, wetland areas, river boundaries, areas with gradient of more than 25 degrees, and native-owned lands. Regarding the latter, the company engages the leader of the native community before developing any land for plantation use, and does not move forward without the leader's consent. Sime Darby also pays compensation to landlords.

11.3.5 Reforestation

Reforestation is the natural or intentional restocking of existing forests and woodlands (forestation) that have been depleted, usually through deforestation (Wikipedia 2018). In places where forests have been lost or degraded, restoration or reforestation projects may be undertaken to guarantee or accelerate the recovery of forests (Stanturf 2005). In Sarawak, reforestation was aimed to restore the environment; to ensure sustainability in timber production; to provide employment to poor people by offering them engagement in reforestation activity; and to signify the role of agro forestry in the development of rural communities. Rural communities in Sarawak still depend on traditional medicines rather than the services of hospitals (Hua 2004). Agro forestry proposes the planting of medicinal plants and wild fruits instead of timber. It provides financial return and plantation ownership to farmers.

11.3.6 Urbanization

Another cause of deforestation is rapid urbanization (Jones 2010). Population increases in urban centers compared to rural areas (Jones 2010). Urbanization causes myriad problems like congestion, environmental degradation and rapid growth. According to Tan et al. (2013), high-density population conditions put pressure on nature. In Singapore, deforestation is due to urbanization, this island city-state has the lowest area of original forest left. However, Singapore is regarded as a green city because it practices an urban greenery policy. Singaporeans have conventional and rooftop gardens, parks and tree-lined streets. The effects of urbanization are essential in calculating the costs of economic development. Changes in the number of people, migration and industrial revolution speed up urbanization. Urbanization transforms the ecology and causes the loss of agricultural land. This trend is significantly exacerbated by the increasingly aggressive push towards Smart Megacities over the last few years, which leads to additional felling of trees and deforestation even in traditionally environmentally conscious European countries like UK and Germany to make place for 5G masts (Brown et al. 2015; Connectiv.Events 2019; Nina 2019) in favor of faster data transfer and for coal or windmills in favor of cheap energy (Dumke 2018; see also Chap. 13, Sects. 13.3.4.2 and 13.4). The high energy need of Smart Cities due to the large number of technical devices used in them (see Chap. 13), occasionally coupled with populist measures to justify the eco-label of Smart Cities and with legal incentives by subsidies for renewable energies, e.g. in Germany, lead to an overhasty extension of wind energy along with deforestation in favor of windmills, even in windless areas of Germany, meanwhile triggering hundreds of initiatives to stop the extension of windmills to avoid the ongoing deforestation, the endangerment of threatened animal species and the distortion of the landscape by windmills (Dumke 2018; Der Spiegel 2016).

11.3.7 Illegal Logging

Illegal logging comprises many actions, including the violation of laws, particularly, national laws, by human activities such as the sale of timber, and the harvest, transport or purchase of forest products. Illegal logging is pervasive in all parts of the world, including the developing world, where timber provider countries constitute over half of timber exports and production transacted through illegal logging activity. Perpetrators gain certain economic benefits such as reduced legal and regulatory compliance costs and, sometimes, price reduction to boost sales (Reboredo 2013). The immediate deforestation and degradation of forest provokes illegal logging activity (Gani 2013). Illegal activities that incorporate in illegal logging are not only specific to the forest sector, but they also included processing illegal timber, trading wood and producing wood (Bouriaud and Niskanen 2003a, b). Malaysia has become the 10th largest furniture exporter among Southeast Asia countries of tropical timber, timber products and furniture (FDMASIA 2018); at the same time illegal logging was the 4th largest contributor to Malaysia's economy in 2008 (Gani 2013). However, Malaysia's exports and domestic goods were harvested illegally, with harvest overcutting accounting for 40% and illegal logging rate 35% (Greenpeace 2004). In addition, the impact of illegal logging has been categorized into direct impact and non-direct impact, with direct relating to premiums, royalty losses as a part of overall government revenue, while indirect impact is associated with forest and land damage, wildlife loss and possible extinction of endangered species (Gani 2013).

11.3.8 Landslide

Landslide incidents threaten human lives and the security of the public, damaging property and often taking lives. Climate-related factors also can contribute to landslides. as can the unregulated development of slopes due to human negligence

(Ahmad et al. 2014). Besides these factors, deforestation interferes with the soil, causing making it lose its holding capacity during heavy rainfalls, again leading to landslides (Vasantha and Bhagavanulu 2008). Development is another trend that increases landslide occurrence in Malaysia's hilly areas. Over the last 50 years, this development in mountainous centers has generated rapid expansion of areas that have been built-up, usually developed with poor urban planning and inadequate territorial infrastructure (Pellicani et al. 2013). Furthermore, new construction in hillslope areas is unstable (Aksoy and Kavvas 2005); this added to the absence of trees to hold soil after deforestation results in decreased shear strength and subsequent landslide. In the case of heavy rain, the soil particles themselves are affected by shear stress, which also increases the chances for landslide. This is according to landslide expert Satish Thigale (Min 2015).

11.3.9 Mining Activities

Based on Tse (2011), the Mineral Industry of Malaysia states that Malaysia has identified several categories of mineral resources such as bauxite, coal, gold, iron ore, petroleum, silver, tin, clays, copper, natural gas, monazite, limestone, silica, zircon and tantalum. Whether small or large in scale, mining operations are inherently disruptive to the environment, producing enormous quantities of waste that can have deleterious impact for decades (see Chap. 2, Sects. 2.3.1.2 and 2.3.2.3). Environmental deterioration caused by mining occurs mainly as a result of inappropriate and wasteful work practices and rehabilitation measures. Mining has a several activities that potentially adversely impact the natural environment, society and cultural heritage, as well as impacting communities close to mining operations (see Chap. 2, Sect. 2.1). Mining activities may negatively impact commercial and/or non-commercial living resources in the mining locale (see also Chap. 2, Sect. 2.3.1.2). Mining activities can cause erosion, pollute water sources, destroy riverine vegetation and deplete supported origin woodland habitats. According to Sonter et al. (2018), mining poses serious and highly specific threats to biodiversity. However, mining can also be a means for financing alternative livelihood paths that, over the long-term, may prevent biodiversity loss.

11.4 Research Method

The purpose of conducting this study is to investigate the causes, effects and possible risk management steps in the deforestation issues in Malaysia. The research is based on a site survey aimed at collecting all necessary information in an effective manner. The survey offered questions on the causes and effects of deforestation (categories based on collected relevant research, review and revision by the participants in the initial pilot questionnaires. The questionnaire included three parts: the first section had two questions, the first being “What is the greatest contributing factor to deforestation?” and the second, ”What are the negative impacts of deforestation to the societies and environment?” The second section included seven questions, including five questions about level of awareness on deforestation, and two questions on respondents’ general knowledge of deforestation in Malaysia. The third section was to provide or suggest possible recommendations to reduce or eliminate deforestation in Malaysia. The Likert scale was used in the design of the questionnaire, extending from (1 = strongly disagree) to (5 = strongly agree). A non-probability sampling technique called convenience sampling was selected to conduct this study. Seventy-five questionnaires were randomly handed out to selected residents in different areas in Malaysia including some from outside of Malaysia. Only 64 questionnaire forms were filled in and returned. Of these, 5 of them were excluded due to incompleteness. However, 59 questionnaires were considered and analyzed, yielding a response rate of 78.6%.

11.5 Results Analysis

From the survey we conducted, 95% of respondents are aware of the deforestation issue in Malaysia. Furthermore, we gathered data on the effects of deforestation in Malaysia. The findings showed that 24 out of the total 59 respondents report being affected by deforestation there (43%), while those reporting being unaffected were 19 (34%). Among the affected respondents, 15 are from the eastern part of Malaysia, 6 from west and 3 from outside the country (see Table 11.1).

All respondents agreed that palm oil plantations, logging activity, urbanization, mining activities and agriculture are contributing factors in deforestation. The study found the respondents deem palm oil plantations to be the largest contributor to deforestation, among other factors, with a weighted average of 44%. Urbanization is viewed as the second largest contributor to deforestation, with a weighted average of 32%. Other perceived contributing factors to deforestation are shown in Table 11.2.

Table 11.2 shows that most respondents from both East Malaysia and West Malaysia agreed urbanization is the primary cause of deforestation, and only 56% of the respondents from East Malaysia stated urbanization as the highest contributing factor to deforestation, and 40% from West Malaysia perceiving the same. With regard to the participants from outside Malaysia, it was found from the analysis that outsider respondents perceived palm oil plantations to be the main cause and contributor to deforestation. 86% of these believed that palm oil plantation to be the primary cause of deforestation. From the total respondents, 44% selected palm

Table 11.1 Respondents affected by deforestation

	No. respondents (%)
Yes	24 (43%)
No	19 (34%)
Maybe	16 (29%)

Table 11.2 Contributors of deforestation

Causes	East Malaysia	West Malaysia	Outside Malaysia	Weighted average
Palm oil plantations	41%	35%	86%	44%
Agricultural	25%	20%	14%	8%
Urbanization	56%	40%	29%	32%
Mining	13%	35%	0%	14%
Logging	3%	5%	0%	2%

Table 11.3 Effects of deforestation

Hometown	East Malaysia	West Malaysia	Outside Malaysia
Climate change			
Strongly agree	16%	25%	29%
Agree	22%	15%	29%
Neutral	34%	45%	43%
Disagree	13%	5%	–
Strongly disagree	16%	10%	–
Landslide			
Strongly agree	6%	20%	–
Agree	19%	25%	43%
Neutral	47%	30%	43%
Disagree	9%	15%	14%
Strongly disagree	19%	10%	–
Primate extinction			
Strongly agree	3%	20%	29%
Agree	19%	10%	29%
Neutral	50%	45%	43%
Disagree	13%	20%	–
Strongly disagree	16%	5%	–

oil plantation as the primary cause of deforestation, followed by urbanization at 32%, and mining at 13%. 12 respondents strongly agreed deforestation causes climate change. Of the 12, 5 were from east, 5 were from West Malaysia, and the other 2 were from outside of Malaysia. 58% of respondents from outside Malaysia agreed that deforestation will cause climate change, whereas only 38% from East Malaysia with 40% of them in West Malaysia agreed that deforestation could cause climate change. Table 11.3 depicts the results obtained from the respondents who had participated from outside Malaysia on the negative results that Malaysian residents report they may face due to deforestation.

As presented in Table 11.3, it can be seen that the respondents from East Malaysia had the highest percentage value of "strongly agree" that deforestation will cause landslides, followed by 45% of west Malaysians agreeing to the same.

11.6 Discussion and Suggestions

As obtained results from the analyzed generated based on the participants' perspectives, it is noted that the majority of the respondents feel they are affected by deforestation, while others are not sure. A total of 24 respondents who responded affirmatively, 16 were from East Malaysia, 6 from West Malaysia and the rest from out of the country. In fact, most of the deforestation in Malaysia has taken place in East Malaysia (Shoumatoff 2017). Therefore, it is reasonable the majority of affected respondents come from there. The average of respondents who chose palm oil plantations as the main cause of deforestation was 44%, and most of these were from outside Malaysia. However, the majority of Malaysian participants in this survey believed urbanization to be the top crucial factor of deforestation, with 56% from East Malaysia and 40% from West Malaysia. However, it concluded that palm oil plantations are a main cause of deforestation, since this category has the highest average among all of them, and it cannot be denied that Malaysia is one of the biggest exporters of palm oil. As Basiron (2004) stated, palm oil is a good commodity, helping eradicate rural poverty, and Malaysia has a suitable climate for palm, as it leads in palm oil exporting. Our respondents did believe the effects of deforestation could lead to negative disasters such landslide, climate change and primate extinction. Most of the participants from East Malaysian agreed climate change to be the effect of deforestation, while the majority in the western part of Malaysia chose landslide as the effect of deforestation. However, the respondents from outside Malaysia who participated in the survey mostly agreed that deforestation impacts on both primate extinction and climate change. All the above observed causes in our obtained findings are almost in line with past studies' findings. For instance, three in five Malaysians will be exposed to climate change vis-à-vis increasing average surface temperature at the end of the twenty-first century (Tangang et al. 2012). The changes in the forest landscape impact animal life and biodiversity. Turner (1996) in his study showed that hillside developments can have serious irreversible impacts on the immediate surroundings and downstream environments in the form of deforestation, soil erosion, water pollution, the extinction of flora and fauna, flash flood and landslides (Lime and Lee 1992).

11.7 Recommendations

Based on the obtained results, quite a number of respondents chose palm oil plantation as the primary cause of deforestation. In fact, palm oil makes up 15% of Malaysia's total export (Patrick 2017). FAOSTAT (2015) found that palm oil dominates the country's agricultural production with 17.5 million tons produced in 2009; this accounts for about 40% of the world's palm oil production. In 2008, Malaysia exported 14.1 million tons of palm oil (with a value of 903 US$/ton). However, a palm oil plantation requires considerable land to yield a crop. The moist climate of Malaysia suits oil palms. Based on FAO's data about land use in Malaysia from 2007 (FAO 2019), palm oil plantations used about 42,380 km^2 out of 328,300 km^2 of total land area. Before planting oil palm, land must be cleared. In Malaysia, the common techniques to clear the land are burning (Tegnäs and Svedén 2002) or ploughing and weeding (Clay 2004). Such practices actually contribute to several bad effects, such as climate change, landslide and primate extinction. To overcome the problem, in the following section we herewith propose four recommendations we believe serve the solution to deforestation. They are sustainable plantation, reforestation, disaster risk management and vertical housing.

11.7.1 Sustainable Plantation

Sustainable management of plantations is important for ensuring an adequate supply of wood and other forest products for future generations (Sankar et al. 2000). Harwood and Nambiar (2014) state that sustained productivity is, arguably, the best measure for integrating the functioning of planted forests, and changes in productivity signal the direction for changes in response to management practices and ecological events including climate change. Deforestation is one of the critical problems to address, because it has several negative effects. Sustainable plantation management is a safer, better technique of oil palm planting. Through it, a plantation keeps going without negatively impacting the environment. So, it can keep generating benefit both for company and country. Sustainable plantation works by not destroying the forest to build new plantations, but by minimizing the environmental footprint, so that the basic rights of local owners and local farmers are fully respected. The Roundtable on Sustainable Palm Oil was formed in 2004, is headquartered in Zurich, Switzerland, and has its secretariat office in Kuala Lumpur, Malaysia. It aims to promote the growth and consumption of sustainable palm oil products while using credible global standards in producing palm oil and active engagement of stakeholders. It has more than 3082 member organizations. RSPO is now a standard for sustainable palm oil, consisting of eight principles and criteria that should be fulfilled by members. The principles and criteria relate to social, environmental and economic good practices. In order to build a sustainable plantation, following guidelines and principles of RSPO will be beneficial for any plantation company in implementing sustainable palm oil plantation.

11.7.2 Reforestation

Locatelli et al. (2015) stated that tropical reforestation has been highlighted as an important intervention for climate change mitigation because of its carbon storage potential. Reforestation and afforestation have both been integrated as forestry-based mitigation schemes into the international climate change regime (Aguilar et al. 2007;

UNFCC 2001). Reforestation is the reforestation of forests that have been barren; it is the planting of forests that are barren due to felling or due to natural disasters. The purpose of reforestation is to improve the quality of human life, especially through enhancing the quality of natural resources. The other benefit of reforestation is to maintain the balance of nature between people, who need to live well, and the rest of nature. Reforestation is useful to prevent flooding, as the roots of the trees protect the soil and prevent the runoff of water, causing flooding. The practice also helps prevent global warming. Reforestation and greening are linked, since by encouraging reforestation, the environment will be cooler, ensuring groundwater availability, and so greater soil fertility. However, reforestation alone is not enough. We must also avoid actions that degrade and pollute the environment to begin with.

11.7.3 Disaster Risk Management

Deforestation can cause landslides if vegetation is not adequate to provide pressure holding in the soil (Abidin 2016). As stated, it is widely known that one of the effects of deforestation is landslide, a disaster that can cost lives. In order to prevent casualties, Malaysia needs a disaster response team who stand ready to handle emergency situations. This has been implemented through the establishment of the SMART team—the Special Malaysia Disaster Assistance and Rescue Team. It was established in May 18, 1994, under the National Security Council with the approval of the cabinet. It consists of several members of the Fire and Rescue Department of Malaysia, the Royal Malaysian Police and the Malaysian Armed Forces (SMART 2017). This team needs to be ready to provide disaster relief and rescue victims. Malaysia must maintain the SMART team to keep evolving as a society that is advancing as the times require.

11.8 Conclusion

Based on the findings and discussion above, it can be concluded that the majority of the respondents were aware deforestation is happening in Malaysia. This aligns with past studies which also showed that palm oil plantation is perceived as one of the primary causes of deforestation (Klara 2011; Wilcove and Koh 2010). Among the respondents, 43% experienced the effects of deforestation in one or in more than one way. Aside from palm oil plantation, urbanization is named the second cause of deforestation in Malaysia by the respondents. The increasing demand of housing complexes and commercial areas under the development of the countries and region cause deforestation in Malaysia (Yong et al. 2014), this is agreed by 32% of the respondents. Aside of palm oil plantation and urbanization, mining, agriculture and logging are also considered causes of deforestation. Meanwhile, the majority of the respondents in general identified climate change, primate extinction and landslides as the effects of deforestation. To manage and reduce the possibility of increased loss due to deforestation, replacing horizontal housing with vertical housing is suggested, as are reforestation, sustainable plantation practices and outing in place excellent disaster risk management teams.

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Chapter 12
Meeting the Stakeholder Needs and Sustaining Business Through Sustainability Risk Management Practices: A Case Study of Malaysian Environmentally Sensitive Companies

Nazliatul Aniza Abdul Aziz and Norlida Abdul Manab

Abstract Sustainability issues such as climate change, carbon emissions, and energy consumption have become increasingly important issues among business organisations, academics and policy makers. Considering this complexity, stakeholders currently demanding companies to have a sound risk management that are aligned to their interest. Sustaining business requires a strong foundational on the economic, environmental and social aspects to address risks and capture value. Sustainability risk management (SRM) is a process that systematically integrates environmental, social, and economic aspects to address emerging risks and other non-quantifiable risk for company survival. This study aims to examine the impact of SRM practices on the company survival among the environmentally sensitive companies in Malaysia. A case study was carried out to examine the SRM implementation among the environmentally sensitive companies. The finding shows that leadership and compliance are considered as important factors in implementing SRM programme. Other factors such as sound risk culture, adequate risk management tools, and effective business continuity planning are crucial to support SRM implementation. Overall findings revealthat the companies are at the early stage implementing SRM programme and denote there is much room for improvement in the risk management process to create long-term value creation for the stakeholders. This study provides empirical evidence on the significance of SRM factors to the company survival. Given the huge environmental and social costs arising from sustainability issues, companies should intensify their effort to fully implement SRM programme across the organisation to sustain longer.

Keywords Sustainability issues · Sustainability risk management (SRM) · Environmentally sensitive companies · Company survival

N. A. A. Aziz · N. A. Manab (✉)
School of Economics, Finance and Banking, College of Business, Universiti Utara Malaysia, Sintok, Kedah State, Malaysia
e-mail: norlida@uum.edu.my

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12.1 Introduction

The environmental, social, and technological changes present both risks and opportunities. Managing risks has become more challenging due to these changes continously affect company survival. Therefore, companies should manage risks and embrace opportunities deriving from economic, environmental and social aspects to sustain longer.(World Business Council for Sustainable Development 2017). Many companies have begun to integrate sustainability in their risk management process as a mean to sustain the business and meet the stakeholder needs. In addition, the company are also being pressured to address sustainability issues by its stakeholders, thereby, requesting it to manage sustainability risks effectively. Stakeholders are more interested in understand how the company manage sustainabiity issues affecting society. Sustainability risk management (SRM) touches every aspect of company ability to manage environmental and social responsibility risks to enhance stakeholder value for long-term company survival (Lam, 2017). Precisely, SRM assists the companies to have better preparedness to address sustainability risks with a range of tools such as stress testing and scenario analysis. Quantifying sustainability risk is challenging because historical analysis failed to translate the risk into monetised value. According the survey conducted at the WBCSD delegates meeting, about seventy percent of the sustainability and risk professionals stated that their organisation did not have a proper risk management process to quantify sustainability risks (World Business Council for Sustainable Development 2017). The underlying premise of SRM is that every organisation can quantify and translate sustainability risks into monetary value. As a result of rapid urbanisation and industrial growth over the past two decades, Malaysia has also been affected by climate change turbulence (Begum et al. 2011) and flood disasters. Emerging sustainability issues such as environmental degradation and ecological disaster result from agricultural, industrialisation, and socialisation activities which affecting the society at a large should be seriously attended (Mahadi et al. 2011). In line with the Malaysian government's effort to promote sustainability practices in the business strategies, the study on SRM warrants significant attention. Relatively, little empirical research focus on SRM implementation (Manab & Aziz, 2019; Wijethilake & Lama, 2019). In response,this study aims to examine the impact of SRM practices on the company survival, among the environmentally sensitive companies in Malaysia.

12.2 Literature Review

Sustainability risks have grown in prominence following the occurrence of a number of environmental disasters leading to direct financial losses and reputational impacts. These risks are often ignored by the management due to lack of tools and methodologies (Cort and Gudernatch 2014). Because of these concern, SRM is the best approach to manage risks associated with sustainability issues (Anderson 2005;

Nigam and Ramos 2011; Olson and Wu 2017; Yilmaz and Flouris 2010). Inevitably, sustainability provides a continuous improvement and valuable measurement to risk assessments in identifying unintended consequences that may affect the long-term business value (COSO 2013; Olson and Wu 2017; World Business Council for Sustainable Development 2017). The development of risk management from traditional risk management (TRM) to enterprise risk management (ERM) and now with its emphasis on SRM creates a revolutionary thought in the risk management development which consequently contributes to both organisational victory and societal goals. TRM is mainly focused on the pure risk or hazard risk, whereby the risks are managed in a decentralised manner and its main objective is to prevent losses. In TRM, risks are managed individually, and there is no framework to guide the risk management activities (Barton et al. 2002). In the early 1990s, an evolutionary risk management discipline referred to as enterprise risk management (ERM) reforms the traditional way of managing risks (Farrell and Gallagher, 2015). ERM considers breaking down the silo approach to managing risks and has caught the attention of most organisations as a strategic tool to manage all types of risk exposure across an organisation (Beasley et al. 2015). The differences between TRM, ERM, and SRM in terms of the nature and scope of risks, time horizon, management of risks, measurement of risks, and impact and likelihood of risks are summarised in Table 12.1.

Unlike TRM, ERM looks at a portfolio view of risks supported by a framework to provide a structure and procedure to manage risks effectively for enhancing shareholder value(Beasley et al. 2005). ERM is a process that manage all types of risk in an integrated way across the organisation, which typically involve all business units to meet the company goalss (Pathak et al. 2013). Fundamentally, SRM is an extension to ERM approach that specifically addresses the emerging risks and non-quantifiable risks arising from sustainability issues (Lam 2017). The main motivations behind SRM are to achieve sustained success and to drive improvements in environmental and social performances (Lam and Quinn 2014). Current emerging business trends contribute to the increase of emerging risks and large-scale risks that affect company survival (PricewaterhouseCoopers 2014). Some studies have explored the integration of ERM and sustainability practices. A study by Ahn (2015) which examined the relationship between ERM efforts and sustainability using a sample of 1251 companies' disclosure of ERM and sustainability activities found a strong positive relationship between the performance indicator, sustainability, and ERM processes in the nonfinancial companies, with Tobin-Q as a measure of performance. Accordingly, Ahn (2015) discovered that companies engaging in ERM and sustainability for a longer period were able to grasp more meaningful and value-creating insights compared to companies which were newly engaged in these integration.

Another study by Cort and Gudernatch (2014) examined the prioritisation of environmental and social aspects in the ERM framework to assess and quantify sustainability risks against traditional financial risks in the oil and gas companies. Based on the results, the disclosure of risk factors from 40 samples of oil and gas companies indicated that in practice, sustainability issues were not being captured fully by their businesses, especially at the risk assessment stage where the companies

Table 12.1 Comparison between TRM, ERM, and SRM programme

Traditional risk management (TRM)	Enterprise risk management (ERM)	Sustainability risk management (SRM)
A fragmented risk management (silo based) approach to manage pure risk	A holistic approach to manage all types of risks across organisation	A strategic approach which integrate sustainability and ERM process to reduce the negative environmental and social impacts of company activities for company survival while meeting the stakeholder needs
Narrow view of risks	Broad view of risks	Specific view of risks
Focus on short-term impact	Focus on short-term and long-term impact	Focus on short-term and long-term impact
Risks with loss as a possible outcome and no beneficial gains	Risks come with opportunities	Risks come with opportunities
Hazard risk	Micro risks that are inherent to the businesses	A large-scale risk with low probability, high impact, and rarity
No assessment of impact and likelihood is done because risks are not linked to the business strategy	Impact and likelihood can be assessed, modelled, and linked to business strategy	Impact and likelihood can be assessed and linked to business strategy with future forecasting leading indicators
Risks are controllable	Risks are controllable and can be predicted using historical data	Sustainability risks are beyond the control of an organisation
Seek to prevent losses	Seek to increase the shareholder value	Seek to ensure company survival and meet the stakeholder needs
Risks are not quantified into value	Risks can easily be quantified into monetary value	Risks are difficult to be quantified into monetary value

were less committed to measuring and managing sustainability risk. They also discovered that the companies treated sustainability risks separately from other types of risk in the ERM process because these risks were managed by the health, safety, and environment (HSE) management. Furthermore, Subramaniam et al. (2015) analysed the factors that affect the integration of carbon-related risks and opportunities into the ERM system among Australian companies from various sectors such as energy/utility, financial services, manufacturing, retail, transportation, mining, and others. Their study discovered that the involvement of senior management, internal audit oversight, resource availability, and energy sector membership influence the extent of carbon risk integration into the ERM system.

SRM is becoming an important component of corporate governance and a means of creating value for all stakeholders. Following the Malaysian Code of Corporate Governance (MCCG, 2012), companies listed under Bursa Malaysia are required to integrate sustainability in their core decision-making for serving the stakeholder needs. In point of fact, MCCG 2012 encouraged listed companies to embrace sustainable business practices while being responsive to emerging trends, risks and opportunities.

Companies are now recognised that their business activities pose environmental and social impacts to the societies. As such, environmental and social risk are greatly matters to the companies that embrace sustainable business practices. They believed that both risks are significantly affect their survival (Mateescu et al. 2016). SRM is essential for company survival. Hence, many companies have started to integrate sustainability into their ERM strategies following numerous environmental disasters threatening their survival (Beasley and Showalter 2015). As a matter of fact, an increasing number of investors and other stakeholders are demanding company to address sustainability risksfollowing global concerns on sustainability issues. Ortiz-de-Mandojana and Bansal (2016) postulated that companies that embraced sustainability practices in their business strategy are capable of managing risks better, experience lower financial volatility, and record higher sales growth This simply relates that sustainable companies can grow profitably in a long term and cater diverse stakeholder needs while managing risks. Therefore, SRM present opportunities to engineer a win-win situation for both businesses and stakeholders.

Studies have identified several determinants that encouraged SRM implementation in various sectors which are good business practices (Das 2014), occurrences of unexpected events (Taleb et al. 2009), stakeholder pressure (Kytle and Ruggie 2005), regulatory compliance (Benn et al. 2009), corporate reputation (Jacob 2012), operational efficiency (Nigam and Ramos 2011), and long-term shareholder return (Przychodzen and Przychodzen 2013). Whilst, Shrivastava and Addas (2014) indicated that corporate governance characteristic such as board discussion on risk has a significant influence on the company sustainability performance. Apparently, SRM determinants could be drawn either externally outside the organisation or internally inside the company.

. For a company to successfully implement SRM programme, factors such as compliance, risk governance, risk culture, and leadership requires attention of the management. Companies are expected to pay more devotion to enhance board and senior management leadership and stakeholder engagement to ensure the effectiveness of SRM in the company. In addition, commitment to comply with regulatory requirements also supports SRM programme. Compliance is essential to good business practices and deliberate effort to meet the stakeholder needs, hence encourages company to address environmental and social risks effectively (Rahardjo et al. 2013). Also, risk governance which applies the principle of good governance is crucial to prepare for unexpected risks arising from sustainability issues (Renn, 2014). Furthermore, risk culture is foundational to efficient risk management practices. Risk culture has to be embedded across the organisation to enhance employees understanding and awareness in regards to the risks threatening company survival (Lam 2017).

12.3 Research Methodology

The present study employed the qualitative research method through the case study approach. Under this approach, the person in-charge of risk management activities from environmentally sensitive companies representing three industries were interviewed. A case study was particularly appropriate and relevant for this study since it provided the researcher with an understanding of the phenomena of interest and produced additional knowledge on a particular study (Sekaran 2006). Prior to conducting the field studies, the study developed an interview protocol to discuss the factors influencing the SRM practices and the impact of SRM on the company's survival. The interview protocol was pretested by several risk managers to help ensure the face validity of the protocol. On top of that, environmentally sensitive sectors play a vital role in the Malaysian economy because they are among the largest contributors to the country's gross domestic product (GDP) (Bank Negara Malaysia 2014). The business operations of these industries rely heavily on natural resources and technologies to achieve their outputs, thus, their operations have detrimental impacts on the environment and society (Mokhtar and Sulaiman 2012). Furthermore, investors are becoming more aware on the fact that sustainability is a viable strategy to lead better-informed investment decisions. For this reason, listed companies are becoming more interested in integrating sustainability to enhance their ability to access funding in the capital markets (Charlo et al. 2015). The interview data were analysed using thematic analysis. In general, thematic analysis provides a style of writing by bringing out the themes to identify similar patterns from the answers, providing flexibility to the researcher to produce a rich and detailed set of data (Braun and Clarke 2006). The interview data were subsequently transcribed and codified to enable the researcher to reflect on the actual meaning of the interviewees' answers. Consecutively, the interview data were coded thematically and summarised.

12.4 Results

This section presents the analysis of the interview data from the companies chosen for the case study. The views of the interviewees had provided more insight into the SRM implementation of each case. The data were analysed based on specified themes.

12.4.1 Profile of Companies and Interviewees

Three companies from the environmentally sensitive industries – plantation, construction, and manufacturing – were chosen for the case study, and these companies had been named as Company A, B, and C to preserve their confidentiality. Company A is a national automobile manufacturer that is involved in automobile design, manufacturing, marketing, and sales. It was established in 1983 and was listed in Kuala Lumpur Stock Exchange in 1992. The company is a subsidiary of a leading automotive manufacturer. The interview session was conducted with the head of risk management department which had more than 20 years of working experience and was responsible for the risk management activities at the group level.

Company B is a construction company that is involved in the field of engineering, quarrying, township, and property development. It was established in 1995 and was listed in the Kuala Lumpur Stock Exchange in 1996. The interview session was conducted with the head of internal audit department which had more than 12 years of working experience in the field of audit and risk management. Moreover, Company C is one of the biggest producers of Malaysian crude palm oil, and it is the world's third largest plantation operator. It was established in 2007 and was listed in the Kuala Lumpur Stock Exchange in 2012. The company's core business activity is cultivation of palm oil and other plantation crops including soybean, canola, oleo chemicals, and sugar products in Malaysia and few other countries. The interview session was conducted with the head of risk management department which had more than 24 years of working experience in risk management.

12.4.2 Interview Results

12.4.2.1 Factors Determining the Success of SRM Implementation

The study found that senior management leadership, board oversights, and compliance with rules and regulations are the factors driving the successful SRM implementation in all three companies. Moreover, elements such as effective communication between the senior management and board, investing in training, in-depth knowledge at the management and board level, and employing incentive schemes that promote sound risk management seemed to be linked to SRM implementation. The cases supported that the corporate boards had mandated the senior management to focus on sustainability issues because these issues were sought after by the investors to see the sustainability of the organisation. Furthermore, the top-down commitment and support at the different organisational levels in the companies studied provided a direction to balance risk and reward for successful SRM implementation. In this study, it was ascertained that compliance with rules and regulations was a critical factor that was the main driver in implementing the SRM programme. This is because all of the companies studied faced much stricter regulations from the regulatory bodies due to their nature of business. Company A indicated that compliance with the applicable laws and regulations was essential to avoid the risk of non-compliance. As an automobile manufacturer, Company A has a responsibility to ensure that their products meet the product quality and safety requirements in accordance with the rules and regulations to avoid reputational risk. Plus, Company B and C indicated that active application of policies, procedures, and controls helped to streamline their company's business operations. This shows that compliance is a form of risk management. Effective compliance plan helped Company B and C to address the compliance issues related to health and environmental protection. Meanwhile, Company C was required to meet the sustainability standards and certifications by international regulatory bodies to demonstrate sustainable performance and to ensure the products consumed by customers are from sustainable sources. In fact, Company C, which had issued their first sustainability report, used the standards in the Global Retirement Index (GRI) framework for its sustainability reporting.

In order to address the new challenges of the changing risks, the interviewee from Company C advocated that the leadership role should ideally be underpinned by a strong risk culture promoted across the enterprise. The company is more concerned in promoting a good risk culture; however, unethical behaviour from senior management had dropped down the share value. The company further revealed that the appointment of board of directors among individuals that have political interest in the organisation led to exploitation of power and responsibility. This implies that the presence of politician in the board of directors appeared to have negative effects on the risk culture because the company's ownership and controls are transferred to individuals with multiple interests. Supposedly, the boards are responsible for cultivating positive risk culture and portraying high integrity and ethical behaviour among the employees in order for the entire workforce to realise the benefits of the risk management programme. In the same vein, Company B, which partially implemented ERM across its business segments and had the ERM activities under the supervision of the internal audit department also experienced difficulties to promote a strong risk culture across the organisation due to the lack of understanding on risks among its employees. In contrast, the interviewee from Company A believed that risk culture is fundamental in any changes in risk management practices. Thus, the company had allocated its resources to initiate training programmes such as continuous risk management workshops and literacy risk programmes to enhance the understanding of their employees at all levels. Apparently, risk culture is a continuous process which is the responsibility of the senior management leadership, and, thereby, the understanding of risks across all departments is crucial in order to achieve the best results. In sum, the findings showed that a weak risk culture in the two case companies Company B and C impeded the success of SRM implementation.

The study also found that nearly all companies studied were experiencing difficulties to quantify emerging risks due to the lack of risk management methodologies and tools. Most of the companies found difficulties to measure emerging risks because they only depend on the risk map and strategic planning to identify the emerging risks using the SMART criteria: specific, measurable, achievable, realistic, and time bound action plan. Specifically, the strategic planning was integrated into the risk management process to measure the strategic impacts of the internal and external risks. Due to the lack of specific methodology to anticipate emerging risks, the case of Lahad Datu standoff in 2013 was overlooked by the risk management committee (RMC) in Company C. Fortunately, the occurrence of military conflict at Lahad Datu had minimal impact on the company value. This highlights one vital point: companies can no longer assume that the information that they have about their businesses is always true. Inevitably, Company A suggested that specific measurements and indicators need to be developed to anticipate emerging risks earlier.

12.4.2.2 SRM Implementation and Its Impact on Company Survival

Since the Malaysian Code of Corporate Governance 2012 and Bursa Malaysia Listing Requirements are applicable to all public listed companies, all the case companies are required to facilitate sustainability practices in their business strategy. The results indicate that SRM implementation is influenced by both internal and external contextual factors. In general, the factors within internal environment exerted greater pressure on the companies than external environment. The internal factors that motivated the companies to implement SRM programme were good business practices, regulatory compliance, and corporate reputation. On the other hand, the external factors that motivated the environmentally sensitive companies to implement SRM were corporate governance compliance, compliance with laws and regulations, occurrence of unexpected events, and stakeholder pressure. The case study findings indicated that all of the companies implemented SRM programme to meet stakeholder needs for sustainability. According to the interviewees, the stakeholders are increasingly paying attention on the sustainability issues and are exerting pressure on the companies to demonstrate sustainable business practices. In fact, the stakeholders also demand the companies to disclose nonfinancial information in a measurable way. Based on the findings, the environmentally sensitive companies were recognising that their operations have a significant negative impact on the environment and society and that, by integrating sustainability into their ERM practices, they would be able to build stronger relationship with the stakeholders. Moreover, all of the case companies shared the same opinion that building good relationship with the stakeholders would ensure positive reputation and gain competitive advantage to financially outperform their competitors. Furthermore, the case companies believed that the effort to engage with the stakeholders help them to reduce risks and translate potential threats into opportunities. Otherwise, the company's reputation would be at risk if it fails to deliver value to its stakeholders. In addition, one of the case companies Company C also emphasised that integrating sustainability into ERM provides opportunity for the company to penetrate its products into the European Union market. At the same time, the approach circumvented unexpected costs which may affect the company's profitability. On the whole, the results indicated that all case companies believed that implementing SRM programme has positive impact on their company's survival over the long-term although they were at the early stage of implementing it. Concisely, the company survival is highly dependent on its ability to balance the needs of all stakeholders while simultaneously assessing potential threats and opportunities.

12.5 Discussions

The study found that only two out of four factors that were identified in the literature to contribute to SRM implementation were present at all three companies, namely, compliance and leadership. Both these factors were determined to be essential, mainly at the initial stage of SRM implementation. The case companies were found to have adequate controls to minimise the risk of non-compliance. Otherwise, the companies would need to bear the unexpected costs if they fail to comply with regulatory measures. This result is clearly in line with the study by Giannakis and Papadopoulos (2016) which suggested that compliance with sustainability regulations and standards is one of the important factors, in addition to risk prevention and mitigation control strategies, to reduce sustainability risks. Furthermore, effective board oversights and senior management leadership were also found to be essential to support SRM implementation. Based on the study done by Subramaniam et al. (2015) which explored the integration of carbon-related risks in the ERM system in energy and utility companies, active support of senior management was also proven to determine the successful integration of carbon risk in the ERM system. Thus, board oversights and senior management leadership are crucial to ensure effective SRM implementation.

The case findings demonstrated that the need to comply with the Malaysian Code of Corporate Governance 2012 (MCCG 2012) had created awareness among the companies to implement SRM programme. Indeed, these requirements helped the companies to improve their environmental and social performance. The companies that have been considered successful in implementing SRM were not only being driven by corporate governance compliance but also by good business practice. This finding of the study is consistent with the studies by Manab et al. (2010) and Gates (2006) on ERM. According to Cuomo et al. (2016), corporate governance and risk management requirements are vital in order to stabilise, maintain, and increase the growth of companies in the longer term. Despite the high volume of incidences like environmental disasters, the study found that the case companies failed to manage and quantify the sustainability risks due to lack of risk management tools. Cort and Gudernatch (2014) suggested that dynamic risk management methodologies and tools are needed to assess and quantify sustainability risks against traditional financial risks because sustainability risks have intrinsic long-term effects on an organisation. In addition, the result showed that the share value of one of the case companies dropped because the board of directors appointed a number of individuals with political interest. Due to the unethical behaviour, the risk culture of the company became weak, and this affected its reputation and performance. Strong risk culture is an indicator of effective risk management capabilities, whereby the company has greater ability to proactively manage various spectrums of risk (Ashby et al. 2012). According to Roeschmann (2014), strong governance reinforces a positive culture, and therefore, the board should demonstrate good business practices throughout the organisation. Other vital factors contributing to effective implementation of SRM that were highlighted and discussed in the case study were (i) good strategic planning, (ii) knowledge management, (iii) sufficient resources, (iv) appropriate risk measurements and tools, and (v) effective business continuity plan. According to Amui et al. (2017), companies that fulfil the needs of their stakeholders have better chances of survival over the long run. The result also reinforced that meeting the stakeholder needs is essential for any company's survival. Accordingly, implementing SRM programme is proven to ensure that the needs and concerns of multiple stakeholders are taken into account in the board's decisions.

12.6 Conclusion

SRM practices are an important research area that deserves more attention. This study contributes to the discussions in this area by examining the impact of SRM practices on the survival of the environmentally sensitive listed companies in Malaysia. The findings showed that compliance and leadership affect company's survival. Since the companies under study were at the early stage in implementing SRM, compliance with laws and regulations was crucial to avoid unexpected costs that might threaten their profitability. However, merely focusing on compliance is inadequate because the companies require strong commitment and support by the board and senior management to take on the responsibility of recommending ways to improve the risk management processes. Based on the findings, companies need to have a persistent strategic planning, progressive knowledge management, sufficient resources, appropriate risk measurements and tools, and effective business continuity plan to successfully implement SRM.

The study also highlighted that environmentally sensitive companies must not focus on short-term impact of risks, but they have to consider the long-term impact of risks as well. SRM implementation serves the objective of environmentally sensitive companies to enhance their value and reputation in the eyes of their stakeholders for long-term corporate survival. Thus, this research supports the practitioners with a better understanding of how to implement SRM programme effectively. Future researchers could also address the need for effective key risk indicators which may enhance the company's capabilities to report risks, prevent crises, and mitigate problems in a timely manner.

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Chapter 13
The Role of Smart Cities for the Realization of the Sustainable Development Goals

Odile Schwarz-Herion

Abstract Smart Cities are often promoted as green cities, facilitating the realization of the UN Sustainable Development Goals (SDGs) by fostering ecological mobility and using Smart Grids, Big Data, the Internet of Things (IoT), algorithms, and Artificial Intelligence (AI) embedded in a resilient infrastructure to optimize energy efficiency, water safety, and food safety, thus offering citizens a clean, safe, friendly, and pluralistic social environment. According to critics, however, Smart Cities involve the danger of a global surveillance society. Furthermore, the density of smart mega-cities might make city dwellers easy targets for covert cyberwar or terrorism involving weapons of mass destruction (WMD). The aggressive push for Smart Cities also enhances the rural exodus, adds to soil sealing, and increases the scarcity of essential resources due to an increasing demand for energy and materials to keep smart cities running, coupled with an enormous ecological backpack due to a dramatic increase of construction projects. Finally, it will depend on the actual implementation of Smart Cities, the availability of alternative lifestyles for those who prefer life in the countryside, and the responsibility of political leaders on the local, the regional, and the global level whether Smart Cities will facilitate or hamper the realization of the SDGs.

Keywords Smart Cities · UN Sustainable Development Goals (SDGs) · Internet of Things (IoT) · Algorithms · Artificial Intelligence (AI) · Big Data · Covert cyberwar · Weapons of mass destruction (WMD) · Energy efficiency

13.1 Introduction

> A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects. (UNECE and ITU-T Study Group 5 2015)

O. Schwarz-Herion (✉)
Dres. Schwarz-Herion KG Detective Agency, Ettlingen, Baden-Württemberg, Germany
e-mail: EOKK.Black@t-online.de

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Addressing all *Sustainable Development (SD)* pillars, this definition of Smart Cities is especially suitable for the chapter at hand which examines the compatibility of Smart Cities with SD in general and the *UN Sustainable Development Goals (SDGs)* in particular. It also alludes to the definition of SD in the "Brundtland Report" which contains the most widely known definition of SD, stating that "...a development is sustainable if it '...meets the needs of the present without compromising the ability of future generations to meet their own needs'" (Schwarz-Herion 2015a, with further references).

In September 2015, the 17 SDGs from the *2030 Agenda for Sustainable Development* were approved by world leaders at a UN Summit before entering into effect in January 2016 (UN 2018a). The SDGs are an update of the *Agenda 21* from 1992 which had been based on the *Club of Rome*'s 1991 report *The First Global Revolution* as stated in *"Come On!"*, one of the more recent *Club of Rome* reports (von Weizsäcker and Wijkman 2018). Applying to everyone, the SDGs shall help countries not only to eradicate all forms of poverty but also to "...fight inequalities and tackle climate change..." (UN 2018a, c). The SDGs or "Global Goals", described as "the blueprint to achieve a better and more sustainable future for all" (UN 2018b), repose on "...the success of the Millennium Development Goals (MDGs)," (UN 2018a, c) recognizing that the elimination of poverty must go together with strategies generating economic growth and addressing various social needs including health, job opportunities, and social protection while dealing with environmental protection and climate change (UN 2018a, c).

There are numerous definitions for *Smart Cities* (Anthopoulos 2017). The expression "smart" is often used synonymous for "intelligent" regarding persons or "efficient" concerning (technical) devices (Anthopoulos 2017); a city is an urban area with at least 1500 people by sq. mile but differs from country to country (Anthopoulos 2017). So, a Smart City may be defined as an urban area with at minimum 1500 people per sq. mile where intelligent persons use efficient technical devices, but a single definition may not be sufficient. *Frost & Sullivan* found some key parallels among Smart Cities all over the globe, namely, "...smart governance, smart energy, smart building, smart mobility, smart infrastructure, smart technology, smart healthcare and smart citizen" (Singh 2014, with further references). According to the Indian government, a Smart City is characterized by providing "...sustainability in terms of economic activities and employment opportunities to a wide section of its residents, regardless of their level of education, skills or income levels" (Indian Government 2014). Others define a city as "... 'smart' when investments in human and social capital along with traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory action and engagement" (Caragliu et al. 2009).

By contrast, the *International Standards Organization (ISO)* defines Smart Cities as "...a new concept and a new model, which applies the new generation of Information Technologies, such as the internet of things, cloud computing, big data, and space/geographical information integration, to facilitate the planning, construction, management, and smart services of cities..." (Anthopoulos 2017, with further references), thus basing the concept of Smart Cities on those innovations which are intrinsic to the *Fourth Industrial Revolution* (Schwab 2017) while basically neglecting the social, ecological, and economic sustainability of Smart City projects. The ISO definition for Smart Cities has a one-sided technological focus, whereas all aforementioned definitions include social and/or ecological aspects.

Principally, SD consists of an element describing stability ("sustainable") and an element describing change ("development"), thus constituting an innovative change preserving existing essential resources and values while taking ecological, economic, and social factors into consideration (Schwarz-Herion 2015a). Therefore, genuinely sustainable Smart City projects should combine environmental protection and the conservation or renovation of older buildings with the construction of new buildings and innovative technology in favor of the ecological, social, economic, and cultural pillar of sustainable development.

13.2 Mission, Visions, and Image of Smart Cities in the Framework of the SDGs

13.2.1 Mission

Since the trend to further urbanization has increased from ca. 750 million people living in cities back in 1950 to 3.6 billion people by 2011 and is reportedly supposed to increase even further until 2030, 60% of the global population could be urban by 2030 (Romero-Bourbón et al. 2015; Smith 2017). This would lead to an imbalance between the number of persons living in urban areas and the available resources needed to ensure the adequate functioning of a city (Romero-Bourbón et al. 2015). Some suggest solving this problem by expanding information and communication technology (ICT) to most or even all areas of urban life to allow the city providing essential services and resources (especially water and food) to its citizens in an efficient way. Pursuing a common goal like the *triple bottom line* of SD involving cooperation in favor of *economic*, *social*, and *ecological* improvements may allow a city to progress (Romero-Bourbón et al. 2015). The extensive use of ICT might optimize the measurement of various factors by using common standards to facilitate the flow of goods and services to citizens; to shorten travelling ways to save time, resources, and costs (Romero-Bourbón et al. 2015); and to provide increased comfort and security.

13.2.2 Smart City Visions

Various visions are associated with the Smart City as follows (Libbe 2014):

- Value-added vision: In terms of economic policy, the Smart City is seen as a future market with significant growth potential for companies operating in the ICT sector.

- Feasibility vision: Closely related to this, the Smart City is seen as a technological innovation field that will fundamentally revolutionize urban processes.
- Sustainability vision: The Smart City is seen as a solution to existing energy and resource problems by significantly reducing energy and material flows.
- Social vision: The innovative services intrinsic to a Smart City should contribute decisively to improving the standard of living and driving social change.
- Governance vision: Once another understanding of the Smart City concerns changed control and coordination processes in the interaction of various actors from politics, administration, business, and civil society (Libbe 2014).

At least the sustainability vision and the social vision of Smart Cities may fit the SDGs. Finally, this depends on the actual implementation of Smart City projects.

In a next step, we will examine which ones of the 17 SDGs are most compatible with the vision and mission of Smart Cities. The 17 SDGs are as follows (UN 2018b):

- "SDG 1 (No Poverty): End poverty in all its forms everywhere
- SDS 2 (Zero Hunger): End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- SDG 3 (Good Health and Well-Being): Ensure healthy lives and promote well-being for all at all ages
- SDG 4 (Quality Education): Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- SDG 5 (Gender Equality): Achieve gender equality and empower all women and girls
- SDG 6 (Clean Water and Sanitation): Ensure availability and sustainable management of water and sanitation for all
- SDG 7 (Affordable and clean energy): Ensure access to affordable, reliable, sustainable and modern energy for all
- SDG 8 (Decent Work and Economic Growth): Promote inclusive and sustainable economic growth, employment and decent work for all
- SDG 9 (Industry, Innovation and Infrastructure): Build resilient infrastructure, promote sustainable industrialization and foster innovation
- SDG 10 (Reduced Inequalities): Reduce inequality within and among countries
- SDG 11 (Sustainable Cities and Communities): Make cities inclusive, safe, resilient and sustainable
- SDG 12 (Responsible Consumption and Production): Ensure sustainable consumption and production patterns
- SDG 13 (Climate Action): Take urgent action to combat climate change and its impacts
- SDG 14 (Life Below Water): Conserve and sustainable use the oceans, seas and marine resources
- SDG 15 (Life on Land): Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss
- SDG 16 (Peace, Justice and Strong Institutions): Promote just, peaceful and inclusive societies

- SDG 17 (Partnerships for the Goals): Revitalize the global partnership for sustainable development" (UN 2018b)

Although not all SDGs may be compatible with the mission and the visions of Smart City planners, some SDGs might be more relevant for Smart Cities than others. At first glance, SDG 11 which expressly addresses sustainable city development as envisioned by the basic concept for Smart Cities seems most relevant, followed by SDGs 6,7,8, and 9. If and in how far Smart Cities may also facilitate some of the other SDGs will be examined over the course of this chapter.

13.2.3 Image of Smart Cities

The perception of Smart Cities in the general public is divided. Idealists and promoters paint smart cities in the most beautiful colors, depicting them as innovative, pleasant, ecologically clean, safe, and inclusive places (Kufel 2016; Kumar 2017). They deem Smart Cities sustainable and energy-efficient, providing a high level of comfort, great employment opportunities, and unique chances for democratic participation for the citizens living in them (Warren 2017; Kumar 2017; Schwab 2017). Some even believe in the potential of Smart Cities to "save the world" due to energy efficiency and a significant reduction in the number of road accidents by managing city infrastructures with the help of "smart" technologies (Webb 2010; Kufel 2016).

In contrast, critics of Smart Cities paint them in rather dark colors, calling Smart Cities a potential "hacker paradise" (Coleman 2015), "surveillance cities" (Mellor 2017), or even "Orwell's Dystopic Nightmare" (Dykes and Melton 2013; Newman 2015), pointing to their virtually unlimited possibilities for ". . .controlling and oppressing mankind in previously unimaginable ways. . .", calling Smart Cities ". . .a dumb and dangerous idea" (Newman 2015) – especially for those who appreciate privacy and liberty (Newman 2015).

Some Smart City skeptics warn that - instead of being green, clean, smart, sustainable, cleverly designed, well-engineered, fair, safe, healthy, resilient, and affordable - Smart Cities will be characterized by ". . . the internet, the mobile cloud, and a lot of weird paste-on gadgetry" (Sterling 2018) due to mayors trying to raise capital. They cite today's *London* and *Rome* as negative examples for ". . .huge, sluggish beasts of cities that have outlived millennia of eager reformers. . ." (Sterling 2018) with a fast-aging population and a collapsing infrastructure where ". . .climate disaster is taking the place of the past's great urban fires, wars, and epidemics. . ." (Sterling 2018).

Once others wonder whether Smart Cities represent ". . .a futuristic fluffy, Disneyesque paradise" (Express VPN Blog 2016) or ". . .an Orwellian nightmare of torment and confinement. . ." (Express VPN Blog 2016). The coming sections of this chapter might help to clarify this question.

13.3 Smart City Concepts and Their Realization

13.3.1 Preconditions for the Realization of the SDGs and Smart City Concepts

> While the SDGs are not legally binding, governments are expected to take ownership and establish national frameworks for the achievement of the 17 Goals. Countries have the primary responsibility for follow-up and review of the progress made in implementing the Goals, which will require quality, accessible and timely data collection. Regional follow-up and review will be based on national-level analyses and contribute to follow-up and review at the global level. (UN 2018c)

This statement reflects the UN's philosophy to think globally and to act locally, also intrinsic to the *Agenda 21* as precursor for the *2030 Agenda for Sustainable Development* issuing the SDGs. It also shows that the UN considers data collection as indispensable for the SDGs, reminding the precursors of Smart Cities, e.g., Los Angeles in the 1960s and 1970s which relied on Big Data – gathered by the *Community Analysis Bureau* (Valianatos 2015).

Advanced Smart City projects emerged in 2005, when *Bill Clinton* encouraged network equipment maker *Cisco* "...to make cities more sustainable" (Falk 2012). Supported by the *Clinton Foundation*, Cisco started a 5-year-research program culminating in the *Connected Urban Development program* involving the cities of *San Francisco*, *Amsterdam,* and *Seoul* where the technology's potential was tested on pilot projects. In 2010, Cisco launched its *Smart and Connected Communities division*, commercializing the products and services developed during this program (Falk 2012). Independently, *IBM* also started to promote technology to make cities "smarter", focusing on information management, analytical algorithms, and data processing. By comparison, *Cisco*'s Smart City projects include *brownfield projects* like its partnership with *New York*'s *Metropolitan Transit Authority* to improve rail and station monitoring, as well as *greenfield sites* like *Songdo*, South Korea (Falk 2012).

Modern Smart City concepts incorporate the extensive use of ICT, applied to a variety of urban development fields (infrastructure, buildings, mobility, services, and security) - reportedly in favor of resource and energy efficiency, economic competitiveness, and life quality of city dwellers (Libbe 2014). In so far, Smart City projects seem to fit very well into the basic concept of the UN's SDGs at first glance. Both rely on Big Data to fulfill their objectives.

13.3.2 Drivers and Driving Forces for Smart Cities

Drivers for Smart City initiatives are demographic change, development toward the digital society, budget finances, international location competition, environmental goals, as well as re-urbanization, i.e., "...the development of new homes, businesses, and community facilities within existing urban areas..." (Projektgruppe

Smart Cities/Regions 2015; Oxford University Press 2018). Key topics in Smart Cities include, inter alia, Smart Energy and Environment, Smart Living, and Smart Mobility (Projektgruppe Smart Cities/Regions 2015).

Driving forces for Smart Cities include Big Business, above all, *AXA, Cisco, Deloitte, Ericsson, HSBC, Huawei, IBM, Microsoft, Philips, Siemens, Tesla, the Global Environment Facility (GEF),* and *Uber* as well as international entities like the *European Commission* and the *UN*. The different stakeholders pursue different objectives: While private companies, banks, and private investors benefit economically from Smart Cities, mayors might benefit reputation-wise from Smart Cities, whereas international entities can push their ideologies via Smart Cities.

13.3.3 Planning and Conceptualization of Smart Cities

A carefully designed *roadmap* can facilitate the successful realization of Smart City projects. The roadmap within the scope of *the European Platform for Intelligent Cities (EPIC)* project is an illustrative example. The *EPIC* roadmap includes six phases (vision phase, plan phase, design phase, build phase, deliver phase, and operate phase), resulting in the definition of concrete business cases (Dirkx et al. 2013).

Interestingly, *none* of these six phases in the *EPIC* roadmap – basically authored and reviewed by Big Business players like the London-based consulting firm *Deloitte* and the global IT and consulting firm *IBM* – *mentions* the *involvement of citizens*, although the *EPIC* project is purportedly equally beneficial for city administrations, *small and medium enterprises (SMEs)*, and citizens. Nevertheless, a truly smart city can only be built if well-informed citizens are involved at all stages of conception and planning. This involvement shall be based on objective information from the very beginning of each project, reflecting citizens' genuine views and ideas instead of indoctrination and deception by deliberate misinformation and manipulation via the *Delphi Technique* (Koire 2011). Thus, international platforms like *EPIC*, the *United Nations Economic Commission for Europe's (UNECE) platform* (United Smart Cities 2018), or global networks like *ICLEI*, the *International Council for Local Environmental Initiatives* (Koire 2011; ICLEI 2018), should be used as helpful tools for networking, inspiration, and advisory support rather than as the final word for Smart City roadmaps and the implementation of Smart Cities.

13.3.4 Implementation of Smart City Projects

Local people and institutions should be treated as privileged stakeholders by being actively involved into Smart City projects from the very beginning. The step from conception to concrete planning is carried out in spatially limited laboratories (labs) for field experiments as they are already used by several cities, e.g., in *Barcelona* and *Singapore* (Libbe 2014).

13.3.4.1 Financing

The considerable costs of innovative high-tech equipment and the high sums required for Smart City infrastructure make it very difficult to fund Smart high-tech Cities solely by classic municipal funding (Smartcities.com 2016; Maddox 2016). A combination of different financing tools may help (Smartcities.com 2016), although the high technological risk of untested or scarcely tested technology, uncertain *return on investment (ROI)*, and regulatory challenges often deter potential investors (Spedding et al. 2013; Maddox 2016).

Every continent and nation has their own challenges and priorities in financing Smart Cities:

In *Europe*, *EIP-SCC* (*The European Innovation Partnership on Smart Cities and Communities)*, an EU financing tool convening industry, cities, and citizens "... to improve urban life through more sustainable integrated solutions" (European Commission 2017a) deals with city-typical issues from various policy fields, e.g., mobility, transport, energy, and ICT (European Commission 2017b). The *High-Level Group for Smart Cities and Communities* helps to identify key problems to be solved by the *lighthouse projects* (SmartsCities.com 2016). Significant funds can be reaped from *Horizon 2020*, "...the biggest EU Research and Innovation programme ever with nearly € 80 billion of funding available over 7 years (2014 to 2020)..." (European Commission 2017c). *Horizon 2020* is politically supported by members of the *European Parliament* and European market leaders as "...an investment in our future..." (European Commission 2017c) in the center of "...the EU's blueprint for smart, sustainable and inclusive growth and jobs" (European Commission 2017c). Further EU financing instruments include *JESSICA (Joint European Support for Sustainable Investment in City Areas), ELENA (European Local Energy Assistance)*, and *Crowd-Funding*, a financing tool with small contributions from numerous persons via an electronic platform (Hinterberger et al. 2015).

In the *USA*, sources for funding Smart Cities include government and municipality funding, private entity funding, private enterprise, private placement bonds, the *private equity* market, banks, corporate bonds, money market, and academia (Maddox 2016, with further references). In September 2015, the *White House* had announced an investment of US$80 million for Smart Cities. The *National Science Foundation* provided US$60 million for its *Smart Cities Initiative* (Maddox 2016). *President Trump* plans to invest over US $1 trillion to modernize America's infrastructure, to bring business opportunities to the Smart City movement, and to create new jobs (Eastwood 2017; Guerra 2017). Companies like *Cisco* work with cities on technology projects, facilitating a cooperation between financiers, banks, and pension funds (Maddox 2016).

In *Canada*, *The Smart Cities Challenge*, a Canadian-wide competition for municipalities, Indigenous communities (*First Nations*, *Inuit*, and *Métis*), and regional governments, (Infrastructure.GC.Ca 2018) motivates communities to use data, connected technology, and innovation via a smart cities approach by financing Smart City projects. The prizes range from Can$5 million to Can$50 million, depending on the number of inhabitants in the respective community (Infrastructure.GC.Ca 2018).

In *Latin America*, financing mainly comes from public budgets. Additionally, institutions like the *Inter-American Development Bank* are involved in financing Smart Cities (Reportlinker 2017). Due to investments in "...connecting all public services to ICT and fiber..." (Reportlinker 2017), numerous Latin American cities strive for smart technology implementation. Most Latin American governments "...are pursuing nationwide investment plans to further digitalize their countries..." (Reportlinker 2017). The report *Smart Cities in Latin America: Smart Grids and Big Data Create Opportunities for Telcos to Capitalize from Smart City Projects* cites, inter alia, *Cisco*, *Ericsson, HSBC*, *Huawei*, *IBM*, *Philips*, and *Telefonica*. Latin American cities are seeking investment capital of US$9.5 billion for "smart water" infrastructure projects across the continent. A report by the *CDP*[1] highlights "...opportunities to finance urban 89 water projects focused mainly in Latin America..." (Smart Cities World Forums 2018).

In *Australia*, 52 Smart City projects are financially supported by the government within the scope of the *AU$50 million Smart Cities and Suburbs Program* (Reichert 2017). Global networking giants like *Cisco*, *Huawei*'s *Intelligent Operation Centre*, *KPMG Australia*, and *Nokia*'s smart cities network have also penetrated the Australian Smart City market (Reichert 2017).

In *Africa*, a continental initiative for Smart Cities had been kicked off by the *Smart Cities Blueprint*[2] which "...urges African countries to seek non-traditional sources of financing" (Siba and Sow 2017), i.e., smart bonds and public-private partnerships, guaranteeing returns and spread shareholding once a project is implemented (Siba and Sow 2017).

In *Asia*, the growth of the Smart City pioneer *Singapore* in recent decades is attributed to attracting *foreign direct investment* (Hynes 2017), although Singapore had formerly been strongly subsidized by the government (GSMA 2017). Meanwhile, the government of Singapore engages in an export-oriented and business-friendly policy framework supporting foreign investments (Agentshap 2013). In *India*, the funding model for Smart Cities shifts from public resources to contractual *public-private partnerships (PPPs)* (Hariharan 2017). India's Prime Minister *Modi* noted that India "...must look towards urbanisation with sustainability, without looking at it as a problem, but as an opportunity..." (Sagar 2017). Modi has launched a scheme to create 100 new cities in June 2017, although building infrastructure for Smart City projects exceeds the Indian government budget by far. So, India relies on investors from both India and overseas (Sagar 2017). Recently, the *Global Platform for Sustainable Cities* was launched in Singapore – funded by the *Global Environment Facility (GEF)*[3] with ca. US

[1]An international nonprofit organization supported by AECOM and Bloomberg Philanthropies.

[2]Presented by Rwanda's government at the *May 2017 Transform Africa Summit.*

[3]*The Global Environment Facility (GEF)* which had been established toward the end of the *1992 Rio Earth Summit* supports numerous projects all over the globe, financing over 4000 projects in 170 countries (GEF 2018).

$1.5 billion to support cities' green development plans including transit systems, planning integration, low-energy zones, waste management, and food security (Climateactionprogramme 2016). Cities from 11 countries including *Brazil*, *China*, *India*, *Malaysia*, and *South Africa* joined this platform.

13.3.4.2 Key Technologies for Modern Smart Cities

Although Smart Cities do not necessarily rely on a high degree of digitalization to be "smart" regarding Sustainable Development, most publications promoting Smart Cities refer to highly digitized cities equipped with cutting-edge technology. This kind of cities is associated with the *Fourth Industrial Revolution*, "…a world in which virtual and physical systems of manufacturing globally cooperate with each other in a flexible way" (Schwab 2017), going far beyond the use of connected smart machines and systems, involving pathbreaking waves of development in fields of expertise reaching from *renewables* to *quantum computing* and from *gene sequencing* to *nanotechnology* – basically characterized by "…the fusion of these technologies and their interaction across the physical, digital and biological domains…" (Schwab 2017). So, Smart Cities are supposed to apply special technologies which will be defined and explained in the following:

- *Algorithms*, i.e., "…a set of mathematical instructions or rules that … will help to calculate an answer to a problem" (Cambridge Dictionary 2018a, b) to keep Smart Cities running in an optimized way (Daly 2018).
- *Artificial intelligence* (AI), "…the ability of a digital computer or computer-controlled robot to perform tasks…associated with intelligent beings…" (Copeland 2018).
- *Autonomous vehicle*: A vehicle which "…can drive itself from a starting point to a predetermined destination in 'autopilot' mode …" (Gartner.com 2018).
- *Big Data*, characterized by the "3Vs" (Rouse and Bigelow 2016): "…the extreme volume of data, the wide variety of data types and the velocity at which the data must be processed…" (Rouse and Bigelow 2016).
- *Blockchain*, "…a digital database containing information (such as records of financial transactions) that can be simultaneously used and shared within a large decentralized, publicly accessible network…" (Iansiti and Lakhani 2018).
- *CCTV (closed-circuit television) surveillance*: CCTV is "...a system of television cameras filming in shops and public places so that people can watch and protect those places" (Cambridge Dictionary 2018c). Meanwhile, more and more digital "network cameras" transmitting over *Ethernet* or *Wi-Fi* are used (PCmag 2018).
- *Cloud computing* is "…the delivery of hosted services over the internet…," enabling "...companies to consume a compute resource, such as a virtual machine (VM), storage or an application, as a utility…rather than having to build and maintain computing infrastructures in house" (Rouse and Bigelow 2018). *Google Cloud Platform*, *Microsoft Azure*, *Amazon Web Services,* and *IBM* are the leading public cloud service providers (Rouse and Bigelow 2018).

- *Drones*: "A drone. . .is an unmanned aircraft" (Rouse et al. 2018), also known as *unmanned aerial vehicles (UAVs)*, *unmanned aircraft systems* (*UASes*), or "flying robots" (Rouse et al. 2018).
- *5G*, i.e., the fifth generation of wireless systems with network speeds of 20G/bps[4] or higher which is scheduled to be made commercially available in 2020 will support billions of wireless devices (Rouse and Haughn 2018a; SDXCentral 2018; Burrell 2018).
- The *Internet of Things (IoT)*: ". . .the interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data" (Oxford Dictionary 2018a), describing ". . .a world where just about anything can be connected and communicate . . ." (Techopedia 2018a).
- *LED light bulbs*: "An LED light bulb is a solid-state lighting (SSL) device that fits in standard screw-in connections but uses LEDs (light-emitting diodes) to produce light..." (Rouse and Haughn 2018b), providing ". . .an efficiency gain of up to 80% over incandescent bulbs" (Rouse and Haughn 2018b). LED lights make Smart Cities colorful by a broad range of color possibilities (Rouse and Haughn 2018b; Techterms 2018).
- *Robots*: machines resembling living creatures ". . .in being capable of moving independently (as by walking or rolling on wheels) and performing complex actions (such as grasping and moving objects). . ." (Merriam-Webster Dictionary 2018).
- *Sensors*: instruments reacting to ". . .certain physical conditions or impressions such as heat or light . . . used to provide information" (Collins Dictionary 2018).
- *Smart Grid*: ". . .an electricity network based on digital technology. . .used to supply electricity to consumers via two-way digital communication" (Techopedia 2018b), facilitating control, monitoring, analysis, and communication inside the supply chain in favor of higher efficiency, reduction in energy consumption and thus cost, and optimal reliability and transparency ". . .of the energy supply chain" (Techopedia 2018b).
- *Smart meters*: A smart meter is "...a vital component in the realisation of the smart energy grid" (SMS-PLC 2017), ". . .an electrical meter that records consumption in intervals of an hour or less and communications [sic] that information at least daily back to the utility for monitoring and billing purposes" (Wachsman 2013), facilitating two-way communication between the meter and the central system, gathering data for remote reporting via fixed wired connections or wirelessly (Wikipedia 2018a).
- *Wearable devices*[5]: "A wearable device is a technology. . .worn on the human body" (Techopedia 2018c) involving ". . .sensor technologies that can collect and deliver information about their surroundings" (Techopedia 2018c). Wearable technology is able to connect to the Internet, enabling data exchange between a

[4]Up to 100 times faster than current 4G technology which is already 10 times faster than 3G (Burrell 2018)

[5]Also known as "wearable gadgets. . .or simply wearables".

network and the device – an ability which "…has pushed wearable technology to the forefront of the Internet of Things (IoT)" (Investopedia 2018).

Once cities have decided which ones of the aforementioned technologies they really need according to their respective priorities, they should plan in advance how to use them in the framework of their envisioned Smart City projects in an efficient and optimal way.

13.3.4.3 Smart City Infrastructure

A comprehensive *Smart City infrastructure (SCI)* comprises *fiber-optic communications*, *utility right of way (ROW)*, street lights, street furniture, traffic control devices, wireless radios, cameras, and various sensors. These technical devices can be partly owned by the city but may also comprise leased assets and circuits (Adtell Integration 2017). Renewable energies should be an integral part of every sustainable Smart City anyway. Small solar parks might be integrated into the Smart City infrastructure (Sarawgi 2018). This can be supplemented, inter alia, by rooftop solar energy, solar street lighting, solar water heaters, solar pumps, solar traffic signals, and solar concentrator-based cooking (Sarawgi 2018).

There are many Smart City initiatives on a global base, inspired by projects like *LinkNYC* in *New York City* which offers free, encrypted, gigabit wireless Internet coverage to the five core boroughs within the city and connected solutions including IoT, 5G, and cloud. Some Smart City high-tech projects in other cities, however, cannot be fully implemented due to a lack of connected infrastructure (Partouche 2016). The development of 5G and the increasing integration of Internet-enabled solutions are supposed to require more antenna sites and the availability of *fiber connectivity* (Partouche 2016). Powerful fiber-optic connectivity supports cloud computing and Big Data needed for Smart City applications. Smart City projects rely on sensor networks across the entire cityscape connected to Big Data analysis machines targeted at real-time intelligence that informs automated systems to move resources correspondingly (Kinney 2016). Getting smart involves setting up tiny gadgets which must be connected by high-speed and low-latency *fiber networks* capable of carrying the enormous amount of prospective data to "… the cloud based systems that will turn numbers into actions" (Kinney 2016). By extending its municipal broadband network, Hudson/Ohio follows a growing trend in an area occupied by protagonists like *Google Fiber*, *AT&T*, and *Comcast* (Kinney 2016). In April 2016, *Verizon* announced the investment of a high sum to provide a glass-fiber network in Boston to enable future smart city initiatives with 5G mobile services. This initiative was embraced by Boston's mayor who promised to provide the foundation for future technology growth "…by granting every resident expanded access to broadband" (Kinney 2016).

13.3.4.4 Smart Architecture

In the age of the IoT, "...buildings and cities are now expected to be 'smart' and provide digital utility in the form of service to users and operators" (Rossi 2016). Buildings and cities entering the virtual world bring about a transformation of architecture in the age of Smart Cities. While the physical infrastructure is still designed by architects, "...a different kind of architects now takes a prominent role in the build of digital environments and their underlying IT-based systems" (Rossi 2016). Latest IT modelling tools take into account the complexity of "an interconnected system of systems" (Rossi 2016). Building systems, security systems, and fire systems are all integrated into this kind of tools, allowing their providers to offer tailor-made services to Smart City planners (Rossi 2016).

Smart City architecture is also associated with increased density due to "smarter," smaller, more ecological, and lower-cost housing for future cities which are supposed to be restricted in space (Kane 2016). This might include smart buildings including *Smart Homes*, i.e., homes furnished with remote-controlled connected appliances, devices, and sensors capable of interacting among themselves (Bhati et al. 2017). A Smart Home equipment may include air conditioners with temperature sensors interconnected with a web-based management system including smart meters connected to energy providers who can give behavioral feedback in favor of efficient energy usage (Bhati et al. 2017). So, consumers can monitor their electricity consumption in a flexible way along with lifestyle changes to save electricity. Self-regulating *Nest* thermostats can track whether you are at home or away to adjust the temperature and control other Smart Home devices (Newman 2016). Windows of smart buildings automatically darkening themselves on a sunny day, sensors detecting if a room is empty, thus making the heating automatically turn off, and humidity sensors may improve the occupants' quality of life and worker productivity (Harvard Business Review 2016; Robinson 2012; Perry 2017). Smart security features like smart motion sensors and cameras can make buildings burglarproof (Bhati et al. 2017).

A really smart building should be ecological on several accounts. The material for the construction of a smart building (walls, doors, and window frames) and the kind of coloring for the coating surface should equally take into consideration energy efficiency and the health of the inhabitants (Bhati et al. 2017). For the urban population with high-rise buildings, it is crucial to consider both environmental well-being and energy efficiency which may be done by rooftop solar energy making smart cities households self-sustaining in their energy requirements as well as through the design of the architecture with balconies, terraces, and green spaces for vertical gardens (Bhati et al. 2017).

Promoting the construction of many new homes in Smart Cities by the argument that cities lacked affordable and energy-efficient living space is pushed to the extreme in some large US-American Cities like *San Francisco* by architects propagating shrinking smallest living spaces by one-third, planning to "pack" thousands of young high-tech workers into "...12-by-12-foot boxes in high-rises..." (Niesner

2012), each one of them equipped with a combined desk and kitchen table as well as a single bed, giving "…the overall feel of a compact cruise ship cabin." In contrast, some European cities offer apartments of more humane sizes. Vienna, for example, offers Smart Homes in five different apartment sizes ranging from 40 m^2 (one-room apartment) for singles to 100 m^2 (five rooms) for young families at a monthly maximum cost of €7.50/m^2, but renting them still requires additionally a building cost contribution (Wohnberatung Wien 2018).

13.3.4.5 Smart Water

As water is the basis for all life on earth, "…a city cannot be truly smart without smart water infrastructure" (Harris 2018). The notion "Smart Water" concerns drinking water and wastewater infrastructure ensuring its effective management and delivery. A Smart Water system should make it possible to gather usable data on the flow rate, pressurization, and redistribution of water in a city along with an accurate usage and prognosis of water consumption (Leinmiller and O'Mara 2013). A survey by the *US Environmental Protection Agency* yielded that the *drinking water infrastructure* in the USA was basically outdated, requiring upgrades to pipes, treatment plants, and water distribution systems. According to the *American Water Works Association (AWWA),* the modernization of the drinking water infrastructure would cost over 300 billion of US dollars, because water networks leak ca. six billion gallons of fresh water per day due to the age of the infrastructure. So, leak detection by IoT technology can make water systems smarter in the USA (Harris 2018).

Globally, many water networks with aging water infrastructure prone to leakages had to be updated with IoT technologies, "…allowing them to come online and communicate with other parts of the system and city" (Hitachi 2017). These smart water systems use IoT-enabled sensors to collect real-time data in favor of the optimization of water facilities with the purpose to detect possible leaks or to monitor water distribution across the network. Thus, smart water systems allow more informed decisions about water management (Hitachi 2017).

In areas affected by drought, the priority is on water preservation, whereas in areas where water is abounding, the priority is managing storm water and pipe corrosion (Feblowitz and Fox 2017). Water systems among adjacent buildings should be shared for optimized local control within the larger water system (Feblowitz and Fox 2017). Underground garages may be equipped with pumps to empty water and be used to store water from super storms, thus using existing infrastructure instead of relying on new capacity or storage investments (Feblowitz and Fox 2017). Other cities may follow Boston's example concerning water safety: Boston is involved in the *Water Information Sharing and Analysis Center (WaterISAC)* to keep abreast of possible physical or cyber threats to water supplies (Feblowitz and Fox 2017).

13.3.4.6 Smart Energy Management

Energy and resource efficiency are major challenges for Smart City projects, allowing cities to become less dependent on fossil fuels and to protect the natural environment (Euan-Smith and Pereira 2016). *Energy performance contracts (EPC)*, *PPP agreements*, and energy policy planning may facilitate the implementation of energy efficiency measures (Calandrino 2017).

In Europe, investment in smart city solutions is driven by EU energy efficiency targets. 55 of Europe's 157 Smart City projects focus on energy and resource efficiency (Euan-Smith and Pereira 2016). Many European countries have begun to test Smart Grid technology as part of smart city developments. In *Aspern*, for example, a sustainable Smart City is created on the site of a former airfield outside *Vienna* – a project involving a joint venture between the *City of Vienna* and the city's utility companies *Wien Energie*, *Wiener Netze*, and *Siemens* (Euan-Smith and Pereira 2016). By 2028, this area will have ca. 8500 apartments and a commercial campus. Energy-efficient technologies like Smart Grid and smart building solutions will also be expanded to other cities to be tested (Euan-Smith and Pereira 2016).

In *Asia*, several countries, above all *China* and *Japan*, have announced investment packages for *Smart City Development* in favor of energy and resource efficiency. Since the *Tohoku earthquake and nuclear disaster* in 2011, Japan has shifted its focus from nuclear energy to renewable energy sources and Smart Grid technology to protect its cities from the mass power outages and rolling blackouts to make them more disaster resilient (Euan-Smith and Pereira 2016). 15 Chinese cities share knowledge and technical capabilities in Smart City solutions with 15 European partner cities, promoting the development of global Smart Cities to optimize energy efficiency and air quality (Euan-Smith and Pereira 2016).

In *America*, *the Envision America program* has the potential to increase the quantity of Smart City projects in the USA significantly, using the US $160 million funding package for numerous Smart City projects. Corporate partners involved in the program are, inter alia, *GE*, *Qualcomm*, *Itron*, *Landis + Gyr*, and *Microsoft* (Euan-Smith and Pereira 2016).

Home Energy Management as a Service (HEMaaS), designed on the basis of a *Q-Learning algorithm* running on a *neuronal network*, is an innovative, self-learning, and adaptive method recommended by some Smart City experts, offering an adaptable, vital, and resource-efficient platform for domestic energy management. This allows urban districts with large residential buildings to substantially reduce overall energy consumption by lowering or postponing their energy needs during busy periods (Mahapatra et al. 2017).

Innovative solutions like the ones within the *European Innovation Partnership on Smart Cities and Communities platform* might be suitable to address the challenge of managing energy production, distribution, and consumption in European cities (EU 2018). The *Nobel Project*, funded by the EU with nearly 2 Mio €, had developed and tested the feasibility of such a solution by building an ICT-based energy brokerage system, allowing individual energy consumers to communicate their energy needs directly to energy producers, enabling them to optimize the production and distribution of energy (EU 2018). In the framework of this project, a web and smartphone app to buy and sell energy was tested in *Alginet/Valencia*, with 5000 participants in the brokerage system where the authorities tested possible ways of adapting street lighting to match traffic conditions (EU 2018). The energy savings by this app were ca. 12% for citizens, up to 58% for large consumers, and 34% for public lighting.

Since at least 2013, more and more municipalities experimented with Smart Grids for future Smart Cities, but end users have difficulties to grasp the new innovative energy allocation models (Grenoble-Isère 2013). Some case studies conducted in Europe revealed that a significant degree of energy savings by Smart Meters and energy pricings has not yet been achieved as the data provided by Smart Meters failed to enable consumers to understand them or to take action based on them regarding energy and cost savings (Bhati et al. 2017). The years ahead will show whether Smart Grids will regularly incorporate renewable energy sources or whether they will develop into a hybrid industry consisting of a combination of IT and energy without necessarily using renewable energies (Grenoble-Isère 2013).

13.3.4.7 Smart Food

Generally, consumers in cities have little knowledge about the origin and quality of the food sold in super markets. They are used to buy perfectly looking and tasty food, regardless from its nutritional value and the pesticides and other chemicals used in its production such as highly dangerous bleachers in cauliflower. Therefore, smart wrappings and smart supervision of the food supply chain may support food safety in cities. According to food experts, the "…trend towards more natural foods with fewer preservatives, additives and dyes calls for increasing oxygen sensitivity" (Moukowa 2016). Innovative "active" package systems can change the condition of the package product in favor of food safety and quality (Moukowa 2016). The identification of products progressing toward spoilage can be facilitated by time-temperature color indicator plastics affixed to a package or by wireless smart caps on bottles indicating spoilage via a small electrical circuit triggering an electrical signal (Moukowa 2016). *Smart Packaging* can deploy Big Data and IoT to enable dynamic interaction with sensor devices on packaging such as Smart Caps, Smart Labels, *NFC (near-field communication)*, and *RFID (radio-frequency identification)* "...to track the quality of food from factory to store..."(Moukowa 2016). Smart logistics by ICT can help to reduce emissions and to save energy and cost by shortening delivery ways for food (see Sect. 13.2.1).

Nevertheless, shipping food all over the globe due to ever-increasing globalization and the carbon footprint created by long transportation routes between rural and urban areas are neither ecologically nor economically sustainable. Therefore, many Smart City concepts integrate *urban farming* which includes community-based agriculture, community farming, garden plots, roof cultivation, greenhouses on rooftops, cultivation on vertical walls of buildings, as well as interior cultivation with hydroponics[6] with LED lamps, amounting to about 30% of the nutrient needs of city residents (Thorpe 2018). Thus, urban farming techniques should ideally be supplemented by *hinterland farming* around cities which has many obvious advantages: It is safe and hygienic, reduces energy consumption and noxious emissions from long transportation routes, keeps crop-failure-caused food waste down by growing food in a controlled environment, and improves health by fitness if people participate in growing food (Thorpe 2018). Hinterland farming also reduces water pollution by nutrient recycling and the need for artificial fertilizers due to organic waste recycling. Moreover, it makes pesticides and herbicides obsolete and leads to greater water efficiency due to water recycling (Thorpe 2018).

In any case, due to the inefficient use of land in cities, conventional agriculture will never be entirely replaced (Thorpe 2018). Cities should sustain existing farms and fertile soil in and around cities while optimizing traffic connections for public transport of passengers and goods between urban and rural areas rather than jumping headlong into mega construction projects for ostensibly "sustainable" housing, because any additional building projects will lead to further soil sealing.

13.3.4.8 Smart Traffic

While city dwellers already use a variety of transportation options including *car-sharing*, *ride-hailing*, *bike-sharing*, *greenbelts*, and pedestrian paths, the current variety is even further expanded by a number of innovations in this field including *autonomous*[7] *vehicles*, *digital mobility platforms*, sensor-based adaptive price-setting, mobile collaboration-enabled transportation models such as ridesharing, and new social transportation apps (Corwin et al. 2018; Deloitte 2018a). Further mobility trends include on-demand vehicle services and car pools, *all-in-one traffic planning solutions*, autonomous networked cars, shared autonomous cars, *fleet communication*, smart-traffic management, and smart-parking by sensors and the IoT, coupled with commuter GPS and *Bluetooth* (Deloitte 2018b, c; National League of Cities 2016; Government2020 2018). *Tesla*, *Uber*, *Ford*, *GM-Lyft partnership*, and some others have introduced autonomous vehicles as fleets for ridesharing (Tay 2017).

Citibrain, a consortium supported within the scope of *Horizon 2020* (Citibrain 2018a) offers a *Smart Traffic* solution consisting of cheap sensors installed in the city streets and crossroads, providing a nonstop traffic monitoring with wire-free interaction (Citibrain 2018b). This allows management systems and authorities an immediate and efficient traffic control while enabling citizens to reach their destination under consideration of the current traffic conditions, alerting mobile applications and calculating the best route, facilitated by a steady data flow of urban traffic,

[6] Hydroponics is a subset of hydroculture, the method of growing plants without soil, using mineral nutrient solutions in a water solvent (dos Santos et al. 2013).

[7] Also known as *self-driving vehicles*.

recognizing, predicting, and avoiding traffic jams as well as by alarm setups, alerting, instructions, and traffic data for citizens along with statistical analysis and Big Data to facilitate city planning (Citibrain 2018b). *Citibrain's Smart Parking* solution includes "…a parking ticket that never expires" (Citibrain 2018c), a parking system integrating every aspect of parking-space management technology including sensor-based vehicle identification, Messaging Gateway, Payment Kiosks, Digital Parking Boards, Mobile Driver Applications, and a parking management system capturing key performance indicators in real time and transforming them "…into knowledge for better policy and optimised management…" (Citibrain 2018c). This involves informing drivers about the location of free parking lots, decreasing the operating costs, reducing traffic congestion and accidents, improving parking operations, and decreasing contamination spikes (Citibrain 2018c).

A survey conducted by *Deloitte* revealed that flying cars are now getting close to commercial reality – adding a new dimension to an already complex landscape in the Smart City mobility sector. Various prototypes of flying cars already exist. Most of them are capable of *vertical takeoff and landing (VTOL)*, covering distances in the range of 65–200 miles. Popularly known as "flying cars" or "passenger drones," VTOL vehicles are aircrafts which do *not* require runways, can accommodate three to five passengers, and are highly energy-efficient and significantly quieter than traditional helicopters (Lineberger et al. 2018). Passenger drones and flying cars already in the air include China's *Ehang*; furthermore the prototype of *Aurora Flight Sciences*' *eVTOL* to be delivered to Aurora's partner company *Uber Air* in 2020; *Airbus*'s Project *Vahana*, an electrical self-flying helicopter for people and freight transportation; and the flying taxi *CityAirbus*. In 2017, *Geely,* the parent company of *Volvo*, acquired *Terrafugia*, a start-up for flying cars whose VTOL flying car will come out in 2023. Due to regulatory challenges regarding flying cars and passenger drones, some aviation authorities started discussing certification options with some manufacturers. These vehicles are supposed to be manned in the beginning, then supported autonomously, and finally transformed into a completely autonomous airplane. As the technology "is still in flux," regulatory agencies prefer nonbinding guidelines (Lineberger et al. 2018). A suitable infrastructure along with an air traffic management system for passenger drones and flying cars is still missing everywhere. NASA and UBER signed the *Space Act Agreement*, regulating the traffic management of self-flying vehicles (Lineberger et al. 2018). Currently, most people still shy away from taking a pilotless flight. Nevertheless, leading personalities from *Deloitte* think that delivery drones from, e.g., *Amazon Prime Air*, *Google*, and *Alibaba* might "…pave the way for VTOL aircraft operations" (Lineberger et al. 2018), optimistically predicting that passenger drones will follow a similar trajectory as parcel carrier delivery drones, which are currently on their way to commercialization (Lineberger et al. 2018).

13.3.4.9 Smart Health

Smart Health Services in Smart Cities include, above all, *Electronic Health Records (EHRs)*, coupled with AI-, automation-and IoT-based data management. Smart devices facilitate the analysis of x-rays, laboratory tests, and *CT-scans*. Certain AI-apps such as *precision medicine* can help with the early detection of certain deseases, e.g., vascular diseases or cancer. Other smart health devices include *3D printing*, nutrition sensors, and ingestible pill monitors (Financial Express 2018). Furthermore, smart health gadgets and smart fitness trackers allow users to quantify their self movement by monitoring, inter alia, their steps and their heart rate, thus allowing them to watch their health during their fitness activities (Gadgets & Wearables 2018). Smart Health also includes improved air quality by innovative air quality systems, for example, Citibrain's *Smart Air Quality system*, consisting of small sensing stations easily installable in the current urban infrastructure, allowing the system to "…respond more effectively to the problems of its citizens…and obtain objective data on the quality of life…"(Citibrain 2018d). The sensors measure, inter alia, air quality (CO, CO_2, NO_2, O_3, VOCs, and particles), luminosity including solar radiation, noise pollution levels, temperature, atmospheric pressure, precipitation, humidity, as well as wind speed and direction (Citibrain 2018d). Central features of this system include alarms management, risks and emergency situations detection, geo-referencing data, statistical analysis, and life-quality reports. Communications take place via Wi-Fi and/or GPRS/3G/4G/NB-IoT (Citibrain 2018d).

13.3.4.10 Smart Security

As "…the world's cities are bursting at the seams…crime is harder than ever to police" (BBC 2015).*Huawei*'s *LTE technology* – combining a private Internet of Things with new counter-crime and urban security technologies – helps police and emergency services to improve security in cities (BBC 2015). Including a secure wire-free broad band connection as well as various wireline, glass fiber, and microwave technologies, Huawei's Smart City solutions allow public and private services to collaborate in a more efficient way and to keep track of what is happening in general. The *Qognify Safe & Smart City Solution* integrates systems, sensors, and data in favor of comprehensive and predictive situational awareness, providing access to this information to all relevant stakeholders including law enforcement, first responders, *public-safety answering points (PSAPs)*, government agencies, and municipal departments. Using the globally leading *PSIM*[8] *solution*, all available technologies including *VisionHub* for intelligent IP video surveillance, sophisticated suspect search video analysis, debriefing tools managing, and maximizing all incident information during and after a security incident are integrated into a unified security platform, enabling the police, law enforcement, as well as emergency and

[8]Physical security information management.

municipal services to curb crime and to provide public safety (Qognify 2018). Beyond Smart CCTVs as "Third Eye of Secure Cities" (Rahman 2017a), Smart Cities need reliable fire detection systems and may also use drones and robots for firefighting and for law enforcement, although the use of robots and drones for law enforcement is very controversial due to legal and ethical concerns (National League of Cities 2016; Sellner and Durchdenwald 2017; Thielman 2016; Rahman 2017b).

13.3.4.11 Smart Waste

More and more cities all over the globe are testing *Smart Waste Management* solutions to manage resources and costs efficiently while keeping cities clean. Although only few cities, for example, *Santander* in Spain or *Montreal* in Canada, are already testing the equipment of private household bins with the latest sensor technology, several cities start to implement Smart Waste Management solutions in public spaces (Hub Bee Smart Cities 2017). A growing number of cities (e.g., *Amsterdam*, *Atlanta*, *London*, *Melbourne*, and *Philadelphia*) are also implementing solar-powered compacting bins (Hub Bee Smart Cities 2017).

The *Nambucca Shire Council* in Australia installed the *BigBelly smart bin* from *BigBelly Inc., a US firm* specializing in smart waste and recycling solutions for Smart Cities (Veracity World 2018). Similar products, offered by other companies, include *SmartBin* from *Dublin*, Ireland, or *Ecube Labs* from *Seoul,* South Korea. Apart from solar panels harnessing solar energy, the smart bins use sensors to steadily compact the waste which is deposited – reportedly reducing waste collection by up to 85% and increasing the capacity by up to 700% (Veracity World 2018). By communicating information on fill levels and doing collection only when the bin is full, smart bins are supposed to reduce congestion and traffic interruption while helping to keep emissions down by fewer collection visits (Veracity World 2018). Smart bins also analyze area-specific data on waste volumes for better planning and can work as a free public Wi-Fi hotspot (Veracity World 2018). City councils, urban waste collecting companies, retailers, restaurants, office buildings, hotels, and commercial centers use *SmartUp Cities*' waste monitoring solutions involving *ultrasonic* fill-level sensors for containers, smart waste logistics, planning and optimization, and predictive waste management analytics using *AI and machine learning algorithms* to deliver insights that reduce costs and increase revenues along with a *Smart City waste management platform* to optimize the value of their sorted recyclables, their waste streams, and the accuracy of their environmental reporting (SmartUp Cities 2018). *SmartUp Cities'* urban waste solutions monitoring waste containers help to save up to 50% of costs by decreasing operating hours while reducing trucks maintenance, road wear, and keeping noxious and toxic emissions down (SmartUp Cities 2018).

13.3.4.12 Smart Payment Technologies

Smart payment technologies may make cities more competitive by enhancing livability and cost-efficiency (Peeples 2016). Smart payment solutions like the *Visa Global Transit Solutions*, "…a worldwide programme to foster seamless commuting through contactless payments" (Wang 2017), are applied in numerous projects in various cities including *Bogota*, *London*, *Mexico City*, and *Singapore* (Wang 2017). Contactless payment reduces the need for paper tickets, smart cards, and related costs like ticket selling points and required staff, improves the commuting experience by simplifying the payment process, reduces waiting times at ticket machines, mitigates congestion, and even can help countries to reduce expenses related with counterfeit notes (Wang 2017). Meanwhile, *Visa* and *MasterCard* "…entered into Indian mobile payments market by rolling out QR code-based mobile money services to leverage the Indian government's demonetisation policy" (Wang 2017). They collaborate with *Stripe*, *Facebook,* and *Uber* in the USA to deliver funds in real time (Wang 2017). *MasterCard* supports *fintech* start-ups including *Monzo*, *Revolut*, and *N26* to develop mobile banking services (Wang 2017).

13.4 Critical View on Smart Cities: How Sustainable and Democratic Are They?

> The digitization of the urban is driven by business, government and commercial actors as well as civil society. Some find it too slow, others too fast…In addition to numerous opportunities, there are also considerable risks associated with digitization. Communities face many challenges and their resources are always limited. Digitalization promises … efficiency gains … It is important to know your own goals, especially in times of social upheaval…Neither the convenience of citizens nor the return of companies in the digital business should be the top priority. (Lobeck 2017)

This quote summarizes the problems of Smart City projects quite well. While Smart Cities are promoted as clean and safe places due to the general chances they provide (see Sects. 13.1-13.3), they bring about many risks, challenges, and disadvantages which are often ignored or downplayed due to the widespread Smart City hype – apparently stirred up by those who benefit from promoting or implementing Smart Cities (see Sect. 13.3.2). Thus, this section is focused on the risks and disadvantages of Smart Cities and their impact on the ecological, social, and economic pillars of SD in general and on relevant SDGs in particular.

The accumulation of electrical and electronic devices in Smart Cities brings about large amounts of "electrosmog," i.e., "...the entirety of electrical, magnetic and electromagnetic fields...which are thought to have biological effects..." (Educalingo 2018). Renowned biophysicists reveal that man-made technology creating magnetic, electrical, and electromagnetic transmitters *fundamentally* changes the natural electromagnetic energies and forces on the earth's surface, "...radically changing million-year-old pivotal controlling factors in biological evolution..." (Warnke

2008). This led to the extinction of numerous species and is endangering the existence of many others including birds and the honeybee whose existence is indispensable for fructification, i.e., for the very survival of humankind (Warnke 2008). Moreover, human health is also directly affected by *electromagnetic fields (EMFs)*. Thousands of recent studies detailing the toxic effects of EMFs – the radiation surrounding electrical instruments and facilities, electrical wiring, and house wires emanating from communication devices, including radio, television, Wi-Fi emitters, and mobile phones – revealed that constant exposures to even weak radiation can cause a range of diseases (Segell 2010). The former *WHO Director General* and medical doctor *Gro Harlem Brundtland* warned about health consequences from mobile phone radiation since 2002 already, advising people to protect themselves against the radiation from wireless technology, admonishing them to restrict the use of mobile phones to the bare essentials, and alerting them that especially young people should take this matter very serious (Stralskyddsstiftelsen 2015). In fact, scientific studies state that persons using a cell phone as teenagers have a five times higher risk of cerebral cancer than those who had begun as adults (Segell 2010). "Dirty electricity," a *carcinogen* also known as *high-frequency voltage transients*, caused by modern *low-energy electronics* and devices such as plasma TVs, computers, refrigerators, dimmers, and compact fluorescent lamps increases the probability that those exposed to it develop different kinds of cancer including throat cancer, uterine cancer, and breast cancer (Segell 2010). So, members of the *European Union* are now acting fast to protect EU citizens, especially pregnant women and children: Since 2008, *England*, *France*, and *Germany* have removed wire-free connections from public libraries and schools; other countries will follow their example (Segell 2010).

Notably, *smart meters* are associated with considerable risks to physical and mental health. Normal, previously healthy people displayed strange symptoms caused by continuous *pulsed electromagnetic radiation* from "smart" electricity meters right after the *covert* installation of Smart Grids (Wycherley 2017). Therefore, the *American Academy of Environmental Medicine (AAEM)* demanded a *moratorium* for smart meters some years ago and continues to veto them today, arguing that wireless *radio-frequency radiation (RF radiation)* effects accumulate over time due to the permanent exposure to smart meters, pointing to the fact that the latest scientific medical literature poses plausible questions about hormonal, cellular, and genetic effects, as well as blood-brain damage and enhanced risks for certain kinds of cancer due to *ELF*[9] and RF rates such as those of smart meters (Wycherley 2017). There is a particular risk to children from smart meters (Wycherley 2017). According to security experts, there is a significantly enhanced risk of fire and explosions from smart meters threatening millions of households (Rodionova 2017; EMF Safety Network 2018). Last, but not least, smart meters may be *weaponized* for *cyber* or *psychotronic warfare* as apparently done in some areas, where a significantly larger number of cell phone towers than needed are erected (Wilson 2013).

[9]Extremely low-frequency levels.

The *5G technology* (Sect. 13.3.4.2) promoted as alleged necessity for Smart Cities (see Sect. 13.3.4.3), is extremely dangerous due to the use of high-band frequencies of 24 GHz and above, largely consisting of *millimeter waves (MMWs)* – a type of electromagnetic radiation with wavelengths within 1–10 mm and frequencies ranging from 30 to 300 GHz (Burrell 2018). Numerous studies have demonstrated the detrimental health effects of the MMW frequencies. 5G technology brings about *increased* RF radiation exposure associated with numerous diseases including cancer, infertility, cardiovascular diseases, birth defects, memory problems, and sleep disorders as shown by thousands of independent studies (Burrell 2018). According to environmentalists, the almost 300 previously healthy birds which recently fell dead from trees in a park in the Netherlands simultaneously to the installation of a 5G mast had died from a sudden heart failure apparently caused by the RF radiation (Erin 2018).

The large number of electronic devices including Smart Grids in highly digitized Smart Cities requires higher amounts of energy and by far more material resources than conventional cities. The huge heap of electronic waste is one of the disadvantages intrinsic to the *Fourth Industrial Revolution* (see Sect. 13.3.4.2) in general (Schwarz-Herion 2018a, with further references) and highly digitized Smart Cities in particular (Schwab 2017).

The replacement of conventional bulbs by cheap LEDs is adding to *light pollution*, having damaging effects for human health and nature (Ganguly 2017). LEDs enhance the risk for chest cancer for women living close to areas with higher outdoor lighting (Ganguly 2017). The blue light in LEDs – perceived as white by the human eye – disrupts *circadian rhythms* causing a "permanent jet lag," disturbing sleep patterns, and lowering sleep quality by suppressing melatonin at night (Abedi 2018). The blue light can also harm retina cells and inflict cataracts, thus causing severe hazard to the eyes (Abedi 2018). The increase of light pollution by LEDs blocks 83% of the global population and over 99% of the European and US population from seeing the stars at night. LEDs are changing the habits of birds and affecting their health (Ganguly 2017). Containing toxic heavy metals including lead, arsenic, and nickel, broken LED bulbs in landfills contaminate soil and groundwater (Sarah 2018). LED street lights should be used with proper coverings to dim them during off-peak hours, lowering color temperature level and irradiation intensity and making them less noxious to health (Abedi 2018; Ganguly 2017).

Although some architects in seemingly "rich" Western countries like Australia and the USA propagate density areas where many "smart" new homes are to be constructed by the argument that Australians and US-Americans would allegedly take up too much space, arguing that the average floor area of new houses built in China (ca. 60 m^2) would not even take up a third of the floor areas of new average homes built in Australia and the USA (Sect. 13.3.4.4), arguments of this kind are flawed. These numbers and figures referring to *newly* built homes say nothing about the question if these newly built big houses are currently occupied or still empty, how many persons live in each of these houses, or how much floor area is actually occupied by the average citizen in Australia and the USA. In fact, due to the current average loans in Western countries, many Australians, US-Americans, and

Europeans cannot even afford a floor area of 60 m^2, so that numerous old and new homes of this size in supposedly rich Western countries stay empty.

Over the last few years, many new houses have been built all over the world according to the push-principle without asking for the actual demand or for affordability. Although more affordable and more energy-efficient living space is indeed needed in most countries, the artificially pushed construction of many *new* buildings facilitating the equipment with smart technology is probably not quite the best solution for these problems. As shown above, so-called "smart" new homes involving numerous noxious high-tech tools harm humans, animals, and nature – in addition to further soil sealing and a significant ecological backpack due to complex construction projects which are often coupled with the felling of trees and large-scale deforestation. So, instead of pushing the construction of tiny new homes whose proposed size rather resembles battery cages than dignified housing for the usually hard-working average citizen, city planners may think about possibilities to make optimal use of the currently available space by restructuring existing buildings in a way which makes them more family-friendly and more ecological, e.g., by separating large areas of frequently rather spacious old houses with good heat isolation into many smaller apartments of various sizes including family apartments and single apartments which should have sizes between 40 m^2 (for young singles) and 100 m^2 for families and should be offered at affordable prices rather than squeezing the working population into 12-by-12-foot boxes equipped with ecologically harmful and noxious technology in urban high-density areas as planned by some US-American architects (see Sect. 13.3.4.4).

Driverless electric cars (*e-cars*) – often promoted as allegedly "green" and safe cars for sustainable Smart Cities (Balch 2014) – may not be as ideal as they are depicted by their promoters either. Recently, the *General German Automobile Club (ADAC)* compared the total CO_2 balance of all automobile drives in a large study showing that the *e-car* had by far the worst results due to the large battery causing a high amount of CO_2 emissions during production and due to the high energy requirements, whereas the frequently vilified *Diesel* (Kunz and Paulsen 2018) had by far the best eco-balance[10] (ADAC 2018). The eco-balance of *e-cars* would only improve if they would run on 100% renewable energies (ADAC 2018). Since scrapping existing cars and producing new cars cause additional emissions and piles of waste, it may be more environmentally friendly to drive old conventional cars as long as possible and to retrofit them if necessary.

The alleged safety of driverless *e-cars* is questionable anyway. The batteries of e-cars are considered a particular safety risk. Lately, a man burned in a *Tesla e-car* –

[10]In spite of the good performance of *Diesel* regarding the CO_2 balance, the pointless EU norms for fine dust limits in Europe repeatedly provoke demands to ban *Diesel* from the roads (Kunz and Paulsen 2018), ignoring the fact that a reduction of fine dust results in higher NOx emissions (Kaindl 2018) as well as the fact that the fine dust in cities is not caused by the fine dust pollution from *Diesel* vehicles but mainly from the weather as verified by experts from the Fraunhofer Institute for traffic and infrastructure systems, so that a decrease in the operating temperature of *Diesel* engines would be reasonable to avoid the emissions of the far more dangerous NOx emissions (Kaindl 2018).

probably because the batteries accelerated the fire (Deutsche Presseagentur dpa 2018a). Recent fatal accidents happening in test drives of self-driving *e-cars* from *Tesla*[11] and *Uber*[12] – apparently happening when the semiautonomous driving assistant was switched off – make people lose confidence in other vehicles running on the same flawed software because a technical failure is a constructional flaw affecting the entire production process of a specific series of vehicles (Eustacchio 2018). Lawyers warn that "...we cannot talk of technically proven, let alone officially approved driving systems as long as self-driving cars are still in the testing phase" (Eustacchio 2018), stressing that legal accountability is transferring away from the driver toward vehicle manufacturers and software engineers in case that autonomous cars should ever become an "everyday phenomenon" (Eustacchio 2018). Furthermore, the FBI warns that autonomous cars could be used as "lethal weapons," e.g., by criminals overmodulating security features to make cars ignore stoplights and velocity restrictions or by terrorists programming autonomous cars equipped with explosives to turn them into *autonomous bombs* (Harris 2014). Beyond that, autonomous cars can be hacked by laser pointers (Curtis 2015).

Autonomous *e-cars* are only one example for the safety risks of Smart City technology. Cyber wars offer a range of possibilities for serious attacks on a city's economic and physical safety. As 50 billion appliances are supposed to be IoT-connected on a global base by 2020 and as cyber-attacks are increasing in both frequency and sophistication, and critical infrastructure is highly vulnerable to cyber-attacks on essential services like electrical power, telecommunications, health care, transportation, water supply, and the Internet (Rando 2014), cities must brace themselves for potential cyber-attacks. Information systems can be sabotaged by various methods, e.g., by the "Trojan horse" program or a "worm" replicating and "infecting" multiple systems (Rando 2014). According to *IBM*, compromised IoT devices like smart meters, smart watches, and building automation systems can be *weaponized* in a way that they do not only pose a danger to the devices' owners but also to others so that a worm attack on a smart meter could cause power outages for thousands of consumers, even though a worm is only one attack vector in addition to the use of IoT devices as a *distributed denial-of-service (DDoS)* platform and the creation of globally distributed *botnets* (Rando 2014). Cyber security experts warn that especially smart grids are highly susceptible to cyber attacks due to weaknesses in the communications infrastructure and stress that certain energy providers use a Smart Grid at the customer's site which uses the network installed at the customer's site for datasharing via the customer's Wi-fi connection (Brandon 2013).

Cities using a *Supervisory Control and Data Acquisition (SCADA)* system are especially vulnerable to cyber-attacks. Unifying decentralized facilities, *SCADA systems* have poor security protocols lacking identification and encryption security features (Thibodeaux 2017). Hackers attacking a city's *SCADA system* could disable

[11]Killing its test driver (The Guardian 2018).

[12]An *UBER* car ran into a lady walking outside the zebra crossing who died in the clinic later on (Levin and Wong 2018; The Guardian 2018).

a number of city services from a single access point, putting public health and safety at risk by a citywide *blackout* (Thibodeaux 2017). This shows that *cyber warfare* is in fact "…one of the most serious threats of our time" (Schwab 2017) as admitted by Klaus Schwab[13] who is generally very supportive of digitization but cites increased vulnerability to cyber-attacks and loss of privacy as the two major disadvantages of Smart Cities in his book *The Fourth Industrial Revolution* (Schwab 2017). Lowering the threshold of war and blurring the distinction between war and peace, cyber war may equally take place in the digital and in the physical world, hacking and attacking all kinds of connected items –targeting military systems as well as civilian infrastructure including essential resources like food and water (Schwab 2017). Potential adversaries may use cyber war "…to disrupt, confuse, or destroy the enemy's sensors, communications and decision-making capability" (Schwab 2017). The victims of a cyber-attack may not even know *who* is attacking them or *if* they are attacked at all (Schwab 2017). The attacker may be a political adversary, a competitor, or a terrorist, or an attack may be undistinguishable from a mere accident.

Terrorism using *CBRNE materials (chemical, biological, radiological, nuclear, and explosives)* poses a major risk for public health and safety, as well as the economic and political stability on a global base (National Environmental Trainers 2018; Interpol 2018). CBRNE may cause mass fatalities in urban density centers. Intelligence and Security experts predict that "…many CBRNE threats are developing and many terrorist cells are looking at different ways to create destruction across major cities in Europe" (Intelligence-Sec 2018).

The extensive know-how of the British military facility *Porton Down*[14] in the field of chemical and biological weapons (U.K. Government 2016; Gaytandzhieva 2018) may pose a serious threat to densely populated future cities on a worldwide base. In addition to testing chemical and biological weapons on ca. 122,000 animals as well as on human guinea pigs including 20,000 volunteers (Gaytandzhieva 2018; U.K. Government 2016), *Porton Down* also used biological and chemical weapons in field experiments including covert aerial release trials conducted on unsuspecting British citizens from 1953 to 1976 as recently admitted by the British government (Schwarz-Herion 2015c with further references; U.K. Government 2016) and chemical gas attacks on unwitting passengers in the London underground in 2013 (Gaytandzhieva 2018). Particularly *Porton Down*'s menacing experience with the aerial release of bacteria (U.K. Government 2016) may be capable of causing mass fatalities in megacities.

CBRNE weapons of mass destruction may also involve the use of *weaponized drones* carrying explosives or sophisticated chemical and biological weapons (Byus und Shaw 2017). Therefore, cities should be able to resort to efficient *counter-drone systems*, for example, *ApolloShield's anti-drone system* sending unauthorized drones a "go home" command (AppolloShield 2018). Industrial control systems of

[13]Founder and Chairman of the World Economic Forum.

[14]One of the numerous Pentagon-financed military labs existing in 25 countries (Gaytandzhieva 2018).

petrochemical and nuclear power generating stations – regularly automated and controlled by computer systems – can be turned into chemical or nuclear weapons by cyber-attacks which might not only cause critical system shutdowns but also toxic chemical and radiological releases leading to mass casualties. *International Business Times* reported about hackers changing the amounts of chemicals utilized to purify tap water through a cyber-attack on the obsolete IT network of a water treatment station, using the web-based billing system to enter the company's web server (Hill 2016). Although the changes could be reversed before customers were affected, this highlights the strong impact of cyber-attacks on critical infrastructure like water systems (Hill 2016).

An *electromagnetic pulse device (EMP)* or weapon system (*E-bomb*) can generate an energy pulse capable of disrupting a myriad of electrical and electronic systems including vehicle ignition systems, computers, cell phones, and public utility power supplies. The *EMP* of a nuclear detonation can radiate throughout long distances, particularly when the detonation occurs as an air burst. Worst case scenarios might involve simultaneous attacks on the systems of health care, public health assets, and public safety by computer viral, denial-of-service, and/or *EMP attacks* crippling or entirely eliminating the emergency response capabilities of entire communities (Rando 2014). Even resilient and sophisticated *IT firewalls* as part of *national defense assets* have been penetrated and affected by several cyber-attacks from both foreign governments and private individuals (Rando 2014). While the *Fukushima disaster* was supposed to be an accident, *Fukushima* may actually have been destroyed by the *Stuxnet* virus in combination with nuclear weapons as suspected by some due to a number of indicators for a targeted attack, also taking into consideration that ". . .Fukushima Diiachi was an extremely well-run nuclear facility with everything in top notch condition" (Metzger 2011; Rothkopf 2011; Stone and Jacobs 2014; Kentisch 2016).

Directed-energy weapons (DEW) including *microwave radiation emitters*, *particle beam generators*, and *lasers* can produce profound *physiological* and *neuropsychological* effects on targeted populations. *Focused microwave energy weapons* and *laser-type systems* can heat and destroy living tissue. Lasers can inflict blinding injuries. Human health effects by *high-power microwaves (HPMs)* include disruption of physiological mechanisms, thermal injuries, and profound psychological effects, as well as acute fear and panic reactions (Rando 2014).

Every city should have emergency systems at place to be able to react in a timely and efficient manner to CBRNE attacks (Battelle 2018a, b; National Envoronmental Trainers 2018). Many private companies are offering products and services for the detection of CBRNE and CBRNE crisis management (Milipol 2017).

As pyro-terrorists of the future are supposed to do targeted attacks on cities by arson to terrorize noncombatants and to blackmail governments as already predicted by military experts since 2005, efficient firefighting tools, above all a sufficient number of firefighting drones, are especially important to avoid mass fatalities in densely populated Smart Cities (Baird 2005; Tandon 2018).

Other security risks concern potential conflicts between city dwellers from different cultures, ethnicities, religions, social layers, political directions, and mentalities in densely populated areas of Smart Cities. Therefore, military experts state that "...the art of war must seek close interaction with the science of cities..." (Evans 2016), encouraging military analysts to cooperate closely with urban specialists to curb armed violence and to limit deaths associated with an urbanizing world in the near future (Evans 2016). These looming risks deriving from aggregation in urban areas is also taken into consideration by the *Bundeswehr (German Federal Army)* on whose training areal *urban area Schnöggersburg* in *Saxony-Anhalt*, Germany, German soldiers are trained to take action in case of fights and acts of terrorism in intercultural and interreligious urban density areas on German ground (Sasse 2017; Süddeutsche 2016).

Once other Smart City risks affecting the social pillar of SD involve the use of "robocops" and algorithms in the field of law enforcement. Although robots and AI may support and facilitate police investigations to some extent, they cannot replace humans (Weckbrodt 2018). The use of robots for the establishment of public order and security as well as for law enforcement stays very controversial for legal and ethical reasons, triggering violent discussions after a police robot killed a suspect 2 years ago in *Dallas*, USA (Thielman 2016). *Cathy O'Neill*, *Harvard Ph.D. in mathematics*, warns that algorithms may be abused as "weapons of math destruction" by reinforcing discrimination, e.g., in law enforcement and court decisions and could even endanger democracy by targeted manipulation of elections and political polls (O′Neill 2017). These illustrative examples show the potential loss of social intelligence due to the high degree of digitalization and automation of Smart Cities, highlighting "...that new technologies might repress the inductive and deductive processes people use..." (Sennett 2012), turning the Smart City into "a stupefying smart city" (Sennett 2012). Principally, the dependency on automation may ultimately lead to a complete loss of common sense and involve the danger of bringing citizens into line, posing a significant threat to individual freedom and human rights as prerequisites for pluralistic democratic societies which are based on the autonomy of mature citizens (Blogsmartcities 2014).

As the strategic use of Big Data is a crucial innovation factor generating higher sales through new products and services, industrial espionage on a global scale will abound (Završnik 2017). According to surveillance experts, "we are...in the 'golden age of surveillance'" (Timm 2016). Highly digitized Smart Cities greatly enhance the risk of all kinds of espionage including economic, political, military, and private espionage, or even joint spying activities of the state and Big Business applied in Smart Cities which may threaten democracy (Conger 2018; Trentmann and Qinhuangdao 2015; Poole 2014). Leading experts in criminal justice decry secret partnerships of federal and local enforcement officials with *AT&T* circumventing the Fourth Amendment and also reveal that "...IBM and its so-called Smart Cities programme spy on citizens in China as well as the USA..." (Hucklesby and Lister 2018). A fully digitized Smart City, where all areas of life would be monitored around the clock without anonymizing citizens' data would ultimately result in total civic supervision and a complete loss of privacy. Of particular concern is the fact that authoritarian countries like China propagate Smart Cities (Trentmann and Qinhuangdao 2015). Total surveillance carries the risk of abuse by patronizing citizens through social scoring as done in China, where tests for a social credit system have already begun to control the social behavior of citizens by rewarding compliant behavior and sanctioning breaches of compliant behavior (Keller 2018a; Blank 2018; Trentmann and Qinhuangdao 2015). Street lamps with covert video cameras may turn every citizen passing these lamps into a potential suspect (Keller 2018b).

A particularly unpleasant example for illegitimate joint spying activities of authorities and big corporations by Smart City Technology has been the *Lower Manhattan Security Coordination Center* jointly staffed and operated by the *New York Police Department (NYPD)* together with the biggest Wall Street companies – those companies being investigated in 50 states for hypothecation and enforcement fraud who are widely believed to have brought about the *economic breakdown* of the nation (Martens 2012). This center – equipped with thousands of panning, tilting, and rotating cameras to track individuals – had been operated around the clock doing *warrantless surveillance* on hundreds of thousands of law-abiding citizens all over Manhattan involving live feeds simultaneously analyzing pictures by AI to search for certain clothing colors and human characteristics, e.g., searching for a suspicious person based on a search for a red shirt (Martens 2012). This mass surveillance and mass aggregation of data on persons has been widely criticized by the *New York Civil Liberties Union* and civil rights attorneys (Martens 2012).

In contrast, a positive example for the right balance between security and privacy are the cameras developed and currently tested by the *Fraunhofer Institute* in *Mannheim*, Southern Germany (Töngi 2018). These high-tech cameras are equipped with AI, alerting the police in suspicious situations indicating crimes, accidents, or heart attacks. They do this, however, without any face recognition and sound recordings, and the cameras are deliberately not installed all over the city but *only* at *crime hot spots*. The images are sent encrypted by fiber-optic cable to the police station and are deleted after 72 h (Töngi 2018). The same can be said of the program *ThinThread* developed by NSA[15] elite official *William Binney* – an elaborated legally compliant and privacy-friendly program with encrypted data able to filter irrelevant information out of metadata while being investigatively most efficient in the field of *counter-terrorism* – in contrast to inefficient later programs like *Stellarwind* making the NSA literally "drown" in a flood of data while allowing *unconstitutional* surveillance (Gorman 2006; O'Cleirigh 2018).

Beyond posing a major obstacle in their setup for the average consumer due to the many hub devices needed for most lighting and sensor systems, creating difficulties of pairing new devices to a Wi-Fi network, and annoying the inhabitants by stereotype commands (Newman 2016; Heargreaves et al. 2017; Higginbotham 2015; Hill and Mattu 2018), smart devices in Smart Homes as well as ultra-modern Wi-Fi devices peering through walls (Khandelwal 2015) have the potential to take away people's last private retreat, allowing the average citizen even less privacy than

[15]National Security Agency, the USA's national intelligence agency, leading the US government in *cryptology* including *Signals Intelligence* (SIGINT) and *cybersecurity* (NSA/CSS 2018).

currently enjoyed by zoo animals and celebrities (Blogsmartcities 2014). *James Clapper*, the former director of national intelligence, predicted already some years ago that in the years to come, intelligence services could use the Internet of Things for the purposes of identification, control, surveillance, location tracking, and specific recruitment, or to gain access to networks or user data (Timm 2016). The former *CIA* director *David Petraeus* had already made a similar remark back in 2012 by prophesizing that energy-reaping machines linked to "…the next-generation internet using abundant…high-power computing" (Timm 2016) along with sensor networks, tiny embedded servers, and radio-frequency identification would facilitate locating and monitoring "items of interest" (Timm 2016). In any case, smart household devices from smart TVs over smart dishwashers and robot vacuum cleaners up to IoT-connected dolls and barbies communicating with children in manipulative and vulgar terms while recording and/or videotaping the owners and their homes can be abused by intelligence agencies for their own agendas or hacked by criminals for stalking, spying, or kidnapping purposes, e.g., by pedophile networks (Naylor 2017; Michael 2015; Allison 2018; Kölner Stadtanzeiger 2008). The full digitization of cities on a global scale will also entail incalculable risks by making cities highly vulnerable to sabotage (Blogsmartcities 2014) and state espionage, opening up completely new fields of warfare.

State secret services with the best cyber specialists and the most ruthless decicion-makers[16] as well as private intelligence services may use their cyber skills to control and blackmail governments, authorities, and companies worldwide. Already a lower extent of digitalization facilitated this kind of abuse in the recent past: As revealed by Edward Snowden's *Global surveillance disclosures*, the *Five Eyes*[17], above all the US-American *NSA* and the British *Government Communications Headquarters (GCHQ)* and their partner agencies on all continents, abused digital cutting-edge technologies including *fiber-optic cables* for warrantless espionage on citizens, diplomats, and heads of states on a global base, inter alia, for extorsion and assassination purposes, exchanging detailed information about social network activities of citizens across nations and continents. Their illicit actions included, among others, the establishment of fake *LinkedIn* websites by *GCHQ* for the installment of spy-software on the computers of unsuspecting users, the invasion into the booking systems of luxury hotels, the monitoring of diplomats' itineraries by ultramodern technologies, as well as the geographical surveillance of persons in real time to kill them by tactical units and drones (Macaskill and Dance 2013; Wikipedia 2018b).

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[16]Possibly the British Government Communications Headquarters (GCHQ), an intelligence and security organization responsible for providing signals intelligence/SIGINT (GCHQ 2016; Bliley 2017). GCHQ is notorious for having spied on foreign politicians, inter alia, at the G20 where it used an email interception program and key-logging software to spy on delegates' use of computers in addition to monitoring the email messages and phone calls on delegates' BlackBerrys (The Guardian 2013) and which is encouraging teenage girls to become cyber experts (Palmer 2017).

[17]An international alliance of intelligence agencies from the UK, the USA, Canada, Australia, and New Zealand (Wikipedia 2018b; Macaskill and Dance 2013).

In spite of the numerous disadvantages and risks regarding the ecological and social-ethical pillars of SD highlighted above, Smart Cities may at first glance offer more chances than risks for the *economic* pillar of SD. Nevertheless, the high costs involved in planning, building, implementing, and further optimizing Smart Cities might lead to high debt levels which will not only put a long-term financial strain on cities and the citizens living in them but might also make them politically dependent from their creditors. Some vigilant writers already warned years ago that "the next debt crisis will be ecological" (Gunther 2010). As the *GEF (the Global Environment Facility)* which once emerged from the *World Conversation Bank*, founded by *Edmond de Rothschild*, ". . .designed to transfer debts from third world countries to this bank" (TheSovereignIndependent 2018), obliges these countries to hand in their land to this bank, those getting funding from the GEF and its partners in the framework of the many GEF-funded Smart City projects who fall into debt lose the ownership of their land, including resources like water and (food) plants.

According to *McKinsey*, the Smart City industry will be a $400 billion market by 2020, with 600 cities worldwide, supposedly generating 60% of the world's GDP by 2025 (Panetta 2018). Although the production of numerous technical devices including robots will initially create new jobs, it is questionable if the many citizens will benefit from this. The job market will probably change significantly by 2020 when ca. 30% Smart Cities environmental care appliances are supposed to have launched robotics and smart devices in nursing and medical institutions (Panetta 2018).

Currently, the Smart City market seems to be dominated by some industrial giants and few powerful financial institutions, whereas small companies with innovative products and concepts including start-ups have relatively little chance. In any case, digitization and the widespread use of robots and AI in Smart Cities involve the risk that many jobs might be lost in the medium to long term (Eckert 2017; Schwab 2017) – especially once robots will be perfected to the degree that they can take over the production of other robots and products on their own (Frey and Osborne 2013; Eckert 2017). According to the *Boston Consulting Group*, in Germany alone, over 60% of 8 Mio people losing their jobs through digitization by 2025 will be skilled workers; another tenth will be experts and specialists in their field (Frey and Osborne 2013; Eckert 2017). According to the *McKinsey Global Institute*, ca. 800 million global workers will lose their jobs by 2030 and will be replaced by robotic automation (BBC 2017). A study released at the *World Economic Forum (WEF)* shows that women are currently working in ca. 57% of the 1.4 Mio US jobs which will be destroyed by technology from today until 2026, predicting that it will take a century for women to reach gender parity in the workplace (Green 2018). Some fear that digitalization will leave entire population segments with little or nothing to do, finally resulting into ". . .revolution, war or worse" (Rosenberg 2017).

13.5 Conclusion and Outlook

The findings above allow to evaluate the different aspects of Smart Cities in the light of the UN SDGs (Sect. 13.2.2, pp. 224 and 225). Due to the waste of resources and energies, Smart Cities violate SDG 12. As long as the huge amount of energy required for Smart Cities will not be 100% covered by renewable energies, the requirement of SDG 7 cannot be reached either. The increased material and energy requirements needed to build Smart Cities and to keep them running will drive material and energy prizes up – especially if the major part of required energy will continue to be covered by fossil energy or by basically sustainable but expensive renewable energies like solar energy (Schwarz-Herion 2015c with further references) or by cheap, ecologically and socially highly invasive and often rather inefficient renewable energies like wind energy (Molter 2016; Stratmann 2018) involving serious ecological problems along with health risks and security implications, e.g., wind mills built too close to human settlements disturbing humans and animals by noise and shadows in addition to windmills-related deforestation removing essential natural CO^2 sinks (see Chap. 11, Sect. 11.3.6) as well as security risks (Barnard 2017; Schwarz-Herion 2015c, with further references; Schwarz-Herion 2018a, with further references). The high amount of electrosmog and light pollution in Smart Cities significantly decreases the chance to reach SDG 7 (affordable and clean energy). If the energy required for Smart Cities would mainly be won from fossil energies instead of renewable energies, SDG 13 would equally be violated. Smart Cities should also have a sound disaster preparedness, proper disaster response systems, and capable defense systems in place to deal with natural or anthropogenic negligent or willful climate change and all kinds of weather disasters including super-storms, earthquakes, and floods which can also be triggered or enhanced by military use of weather modification or climate engineering techniques (Schwarz-Herion 2015c, with further references; Schwarz-Herion 2018a, b, with further references).

The health threats from “smart” technology, above all from *smart meters* and *5G technology*, clearly violate SDG 3. The extensive spying activities by ultramodern technology violate the second half of SDG 3, because the risk of steadily being spied upon seriously impairs human well-being – in addition to the safety risks which may emerge from spying activities by criminals and intelligence services, thus also violating SDG 11. Even more importantly, the permanent espionage threats in all spheres of life in case of a high degree of digitalization may put peace, justice, and strong institutions at risk if governments and authorities are blackmailed by those spying on them, thus strongly violating SDG 16.

The high risks associated with Smart Cities like cyber-attacks and mass fatalities by CBRNE weapons of mass destruction in urban density centers show that Smart Cities are generally unsuitable to fulfill SDG 11, requiring to make cities inclusive, safe, resilient, and sustainable. The danger of civil wars in urban density areas as indicated by projects like the ones in Schnöggersburg seriously endangers SDG 16.

Smart Cities do “per se” nothing to ensure SDG 4 but may even exclude seniors from fully participating in any educational offers. Apart from that, SDG 4 itself is partly a rather questionable goal, because the *imperative* requirement for lifelong learning regardless of individual wisdom, knowledge, and prior educational or professional experience bears the danger of political indoctrination of adults (Koire 2011), thus favoring fascism.

The job losses due to increasing digitization brought about by highly digitized Smart Cities clearly violate SDG 10, because only the upper layers of society, above all Big Business and some political leaders, benefit from smart cities, whereas small companies and the average citizen, above all women, are threatened by poverty due to job losses. So, Smart Cities equally violate SDG 5 and the second half of SDG8. The first half of SDG 8 is violated by state debt which hampers further economic growth.

State debt created by financing Smart City projects poses a huge threat for SDG 1, SDG 2, SDG 6, SDG 14, and SDG 15, because indebted nations and communities will have to hand in all their land and their resources to their creditors, thus losing control over their land and all resources including soil, water, and air on it, below it, and above it and handing it to actors with unknown intentions who may abuse this power by exploiting land, water, resources, plants including food plants, and maybe even animals and humans on it for their own purposes. Cyber-attacks which are greatly facilitated by highly digitalized Smart Cities may also contaminate water resources in the city as shown above (see Sect. 13.4, p. 247), thus violating SDG 6. SDG 17 is generally a laudable goal, but global partnerships for Smart Cities would multiply the apparent weaknesses of fully digitalized Smart Cities, putting all pillars of SD at risk on a global base.

In sum, highly digitized Smart Cities based on the ISO definition (see Sect. 13.1) have more disadvantages than advantages for all pillars of SD and for the UN SDGs (see Sect. 13.2.2). Possibly, partly digitalized Smart Cities and the use of blockchain technology to protect cities against cyber-attacks may modestly contribute at least to SDG 1 by increased energy transparency, energy efficiency, and increased comfort once the current challenges of smart meters will be overcome and under the provision that 100% of the energy used in smart Cities is actually ecologically, socially, and economically sustainable. Blockchain technology may help to provide end-to-end privacy and encryption by using a decentralized ledger and removing the risk of a singular point of failure (Barzilay 2017) to restore privacy (Hall 2018) and even to fight cybercrime (Schou-Zibell and Phair 2018) and censorship (Hilongs 2018), but this is easier in theory than in practice as shown by the recent cryptocurrency hacks (Orcutt 2018) as blockchains can be cheated, e.g., via an “eclipse attack” by taking control of one node’s communications and fooling it into accepting false data seemingly coming from the rest of the network, thus tricking it into confirming fake transactions (Orcutt 2018).

The use of killing robots should be a taboo in a civilized society. The idea to connect humans to the IoT by implants is legally and ethically completely inacceptable in a free and democratic society. Even *Tesla* founder *Elon Musk* who recently bought up a start-up company researching *brain implants* that will make it possible to connect the brain to computers admits openly that artificial intelligence is the greatest threat to human civilization, while paradoxically requesting that the state must set rules immediately before things get out of control (Brost et al. 2018).

Last, but not least, one should take the repeated claims of steadily increasing cities which would allegedly make building Smart Cities indispensable in favor of Sustainable Development with the utmost caution, because certain individuals and companies may artificially create problems to provide a solution that benefits them economically, politically, or in terms of reputation. After all, neither growing urbanization nor urban density nor digitalization nor Smart Cities are a law of nature but a development merely driven by humans (Vogel 2018; WBGU-Wissenschaftlicher Beirat der Bundesregierung 2017).

Experienced forensic commercial real estate appraisers observed the fraudulent ways in which consultants – paid by the city to find *blight areas* – declared also areas without any blight officially blighted as a pretext to rezone them as “mixed use” or “transit areas” for high-density redevelopment projects, i.e., *Smart Growth* (Koire 2012). They blamed these machinations on an abuse of the *Wildland project*[18] by individuals like the self-nominated environmentalist and billionaire *Ted Turner* who is suspected of releasing an aggressive breed of Canadian wolves killing elks and horses onto the thousands of acres he owns in *Montana* (Koire 2011; Orhai 2013), thus turning rural areas into so-called *“wilderness” areas* by driving country people out into densely populated cities to deprive them of their freedom by making them dependent from food sheds[19] (Koire 2011). A similar M.O. seems to be used in some European countries including Germany, where the sudden appearance of a particular ferocious species of wolves killing numerous farm animals overnight is threatening the existence of farmers and may force them out of the countryside, thus paving the way for turning the area into a wolf region (Deutsche Presseagentur dpa 2018b), i.e., a wilderness area. A deliberate *weaponization* of windmills by building them too close to human settlements, i.e., at a distance of only 650 m instead of at least 2000 m, thus turning them into *infrasound weapons* (Bürgerinitiative Fröhnerwald 2018; Vernunftkraft 2018; Molter 2016; Piper 2011; Whyfor 2015a), is once another covert method to drive people out of rural areas into crowded Smart Cities – apparently “. . .to pack and stack the people and remove every last freedom. . .” (Whyfor 2015b) and to control all aspects of citizens’ life, including food and water consumption (Ajohn 2015). Farmers and other country people affected by such schemes should not allow to let themselves be driven out of their property in rural areas but should proactively investigate the matter and take appropriate legal steps.

Densely populated highly digitized Smart Cities with few green areas and an unfavorable CO_2 balance along with serious health and safety risks for the majority of people on the one hand and *wilderness areas* owned by a handful of extremely rich pseudo-environmentalists and elitist functionaries abusing wilderness areas as

[18]Providing the base for the Convention on Biological Diversity (CBD) from 1992 to 1993 (Schwarz-Herion 2018a, with further references).

[19]Grown within a 100 mile radius to support the population in transit villages (Koire 2012).

hunting ground for imported animals on the other hand (Orhai 2013) are bound to increase environmental damage and the social divide even further. Allowing a tiny minority to exploit ground, water, and natural resources while excluding the majority of people from any chance to live in harmony with nature harms both the ecological and the social pillar of SD as well as most SDGs (see above).

There are certainly better options for the implementation of SD in general and the UN SDGs in particular than pushing Smart Cities as alternative-less solution for existing problems or driving people out of the country side into crowded cities. Viable alternatives include initiatives by committed citizens to make rural areas more attractive by becoming energy-independent by renewable energies like biogas or biowaste while creating themselves good traffic connections by establishing locally operated bus services, thus optimizing the transfer between village and cities along with the creation of new jobs and a self-sufficient infrastructure, e.g., by turning empty farmhouses into exquisite shopping malls offering bio-food, by attracting buyers and tourists from cities, and by encouraging doctors and attorneys to establish their practices and law firms in pictorial villages (Vogel 2018). This kind of initiatives has become rather popular in some places of Germany, because more and more people are detecting the relaxing peace of country life over the hustle and bustle of the city (Vogel 2018).

Eventually, Raskin's trichotomy depicting three simultaneously existing differing kinds of regions (*Agoria*, *Ecodemia*, and *Arcadia*) might offer a chance to tackle the most urgent current problems in the field of SD (Raskin 2006) and to fulfill most or even all of the UN SDGs. These three types of regions as ". . .an optimistic vision of global society in the year 2084. . ." (Raskin 2006) – supposed to be more democratic than all current political systems – would offer humans all over the globe the choice between the more capitalist and consumer-oriented *Agoria* regions which would fit digitalized Smart Cities, whereas the worker-oriented *Ecodemia* regions as "economic democracy" (Raskin 2006) with *eco-socialist traits* or the *Arcadia* regions as the most ecologically and socially sustainable regions would rather find their place in the countryside or in rural suburbs of Smart Cities. The *Arcadia* regions may be suitable for those people who appreciate a calm and traditional life in the countryside where digitalization would be restricted to a minimum, while people in these regions may still be in a position to take part in cosmopolitan culture and world affairs by progressive technologies and transportation services (Schwarz-Herion 2015b, with reference to Raskin 2006), and the *Ecodemia* regions may attract those people who appreciate the life in suburbs as more rural parts of large cities, whereas the people seeking the innovativeness of vibrant, digitalized, and energy-efficient Smart Cities may appreciate the *Agoria* regions.

In a free and democratic global society, people all over the globe should have a choice between the *Arcadia*, the *Ecodemia*, and the *Agoria* regions. In that case, Smart Cities may enrich the political and economic landscape of a future world community. Nevertheless, it would be reasonable to restrict digitalization of Smart Cities basically to regulating street traffic and parking systems in those areas with particularly crowded streets while banning or strictly regulating driverless cars and restricting the use of drones to emergency situations like fire extinguishing, weather disasters, and other emergency situations while banning the use of unmanned drones, robots, or algorithms for law enforcement, public security, or nursing and offering wearable devices only as an option for those who voluntarily use them for safety or health reasons. Beyond that, city leaders should put the focus on *humans* living and working in Smart Cities, using "…the new urban technologies…more intelligently" (Sennett 2012) in terms of vision and urban planning instead of blindly relying on machines in a one-side way. Under these conditions, Smart Cities may positively contribute to SD and some of the UN SDGs.

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