

# Chapter 1

## Sustainable Qatar



Logan Cochrane and Reem Al-Hababi

**Abstract** The Qatar National Vision of 2030 has identified bold and transformational goals for the country. As envisioned by the State of Qatar, the transition to sustainable Qatar weaves together four pillars of economic, social, human, and environmental development. Yet, the country faces significant challenges, and with these challenges a range of options for future pathways. With the National Vision 2030 being launched in 2008, this volume provides an update on the key sustainability issues, focusing on environmental sustainability from a socio-political perspective.

**Keywords** Qatar · Sustainability · Development

### 1.1 Why Sustainability?

Global considerations of sustainability have taken diverse forms throughout human history. Indigenous knowledge systems commonly value sustainability as more important than other economic gains, be that in nutrient management practices in agricultural systems, water management practices in arid environments, or fishing practices that maintained ecosystem balances. Each of these decision-making processes recognized that the longevity of the system required careful and wise utilization. Exemplary of this is the Seventh Generation Principle, which guides people to make decisions that benefit people seven generations into the future (a philosophy rooted in the North American Haudenosaunee Confederacy, called the Iroquois by the French). The Islamic tradition provides principles similarly; the Qur'an explains that people are to act as custodians, caretakers, or trustees (6: 165) on the earth, avoiding excessiveness and wastefulness, walking gently on the earth (25: 63).

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The original version of this chapter was revised: On pages 6 and 9, the running text has been changed. The correction to this chapter is available at [https://doi.org/10.1007/978-981-19-7398-7\\_20](https://doi.org/10.1007/978-981-19-7398-7_20)

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The contemporary concept of sustainability builds on these diverse traditions, seeking to find a balance between the economic, social, and environmental needs of the present while considering the needs of the future. In defining what “sustainable development” is, the Brundtland Report of 1983 and the subsequent 1987 *Our Common Future* report defined the concept as meeting “the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations, 1987, p. 54). In the last five decades, global evidence about environmental challenges has expanded, not only identifying the issues (e.g., biodiversity loss, climate change, deforestation, pollution) but also their interconnectedness. As the evidence has accrued, agreements and commitments at the international level have attempted to ensure sustainability is a global priority, a few include Agenda 21 and the 1992 Earth Summit, the Millennium Development Goals 2000–2015, the Johannesburg Declaration of 2002, the 2030 Agenda for Sustainable Development and the Sustainable Development Goals 2015–2030, the 2015 Paris Agreement on Climate Change, among many others. Despite the evidence and the enthusiasm, the global community is not on track to meet those commitments.

The State of Qatar faces a wide range of challenges related to sustainability, detailed in the following section. In 2008, a strategy was launched to embark on a transformation toward sustainability, as outlined in the Qatar National Vision 2030 (this is detailed in Chapters 2 and 3). The vision weaves together four pillars of economic, social, human, and environmental development. Despite the rapid expansion of country-specific evidence, to our knowledge, no book has attempted to bring together the challenges related to sustainability, in order to integrate the interconnected issues and put forward options that enable positive synergies across sectors and dimensions (economic, social, human, and environmental). This book contributes to this process by bringing together experts working on issues related to sustainability so that students, researchers, and decision-makers can have a broader, more holistic vision. The chapters also provide specific options for the transition toward sustainability, some being pragmatic and others calling for deep transformation. The options provided herein allow us, readers of this book, to assess not only the pathways available for us, but also provide indicators for our progress along those pathways.

## 1.2 Qatar in Context

The State of Qatar is a peninsula on the eastern side of the Arabian Peninsula that is geographically (11,521 sq. km) and demographically (2.7 million) a relatively small nation, in the global context. It only shares a land border with Saudi Arabia, however, within a couple of hundred kilometers of sea other neighbors include Bahrain, Iran, and the United Arab Emirates (UAE). It is beyond the scope of this brief introduction to present the deep history of the country, nor give justice to the periods of time when the lands of contemporary Qatar were ruled by foreign powers. Notable, however, is that it was only in 1971 that Qatar gained full independence. Of all subject areas, history and contemporary politics are of the most analyzed in academic literature,

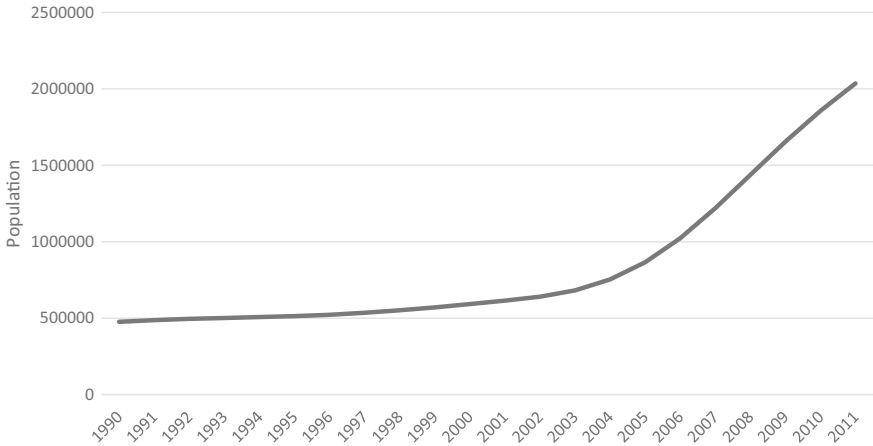
with a wealth of publications available for further reading (e.g., Al-Ejli, 2015; Alkhaateb, 2019; Al-Thani, 2012; Crystal, 1990; Fromherz, 2012; Gray, 2013; Kamrava, 2013; Rahman, 2005; Tok et al., 2016; Ulrichsen, 2014; Zahlan, 1979; Zweiri & Al Qawasmi, 2021).

Drawing upon hydrocarbon resources, particularly natural gas since the 1990s, the country has rapidly transformed into having one of the highest per capita GDPs and has attained a “very high” rank in the human development index. The chapters of this book provide a wealth of context on the contemporary political system; however, we feel that two areas warrant particular attention for this contextualization that complement what the chapters contribute. The first is demographics and the second is the economy, the latter being addressed by some authors as it relates to specific aspects of the economy (e.g., liquefied natural gas, energy); we offer a broader overview that situates those chapters.

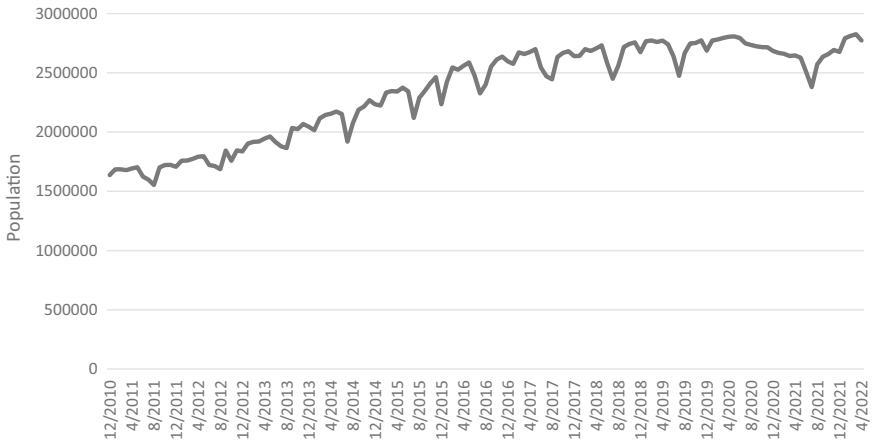
Several chapters make mention of population figures; however, given the unique demographic trends within Qatar, we felt this warranted some context. Historically, the land that is now Qatar was not home to large populations, although trading and maritime towns emerged with populations in the thousands and tens of thousands. In 1960, the total population was less than 50,000 people, and today approaches 3 million (World Bank, 2022). Exploring demographic trends situates the current context as well as supports an understanding of potential future trends. There are no official statistics on the number of citizens in Qatar, although estimates suggest citizens represent only 10–12% of the population. The vast majority of the population are expatriates, and of that population, there is a large working-age male population (resulting in one of the world’s most gendered population structures).

For those not familiar with the State of Qatar, it may have emerged on the radar when it was announced as the country was selected to host the FIFA World Cup in 2022. The resultant construction (e.g., of the stadiums and related infrastructure) might be assumed to be a major driver of this large expatriate workforce, and while this has been a reason for some of the population growth, the majority of the demographic expansion took place in the decade previous when liquefied natural gas (LNG) revenues enabled rapid economic growth. The population more than tripled between 2000 and 2010 (in 2000 the population was 592,467, in 2010 the population was 1,856,329, a 213% increase, see Fig. 1.1).

In December of 2010, it was announced that Qatar had won the bid to host FIFA 2022, at which time the total population was 1,637,443. More than a decade later, as of March 2022, the population had risen to 2,773,598 (a 69% increase, Fig. 1.2). The population growth rate has been slowing, and in particular since 2018, whereafter the total population has fluctuated around 2.7 million. United Nations forecasts suggest that the total population of Qatar will continue to rise, reaching 3.2 million in 2030, 3.7 million in 2050, and 3.9 million in 2100 (2017). However, these projections tend to rely upon more typical population growth rates (fertility, birth and death rates, population age and sex profiles), and in most countries, migration plays a more minor role. Given the unique status of the current population (with a majority being expatriates with temporary residence), as well as the other socioeconomic drivers that may increase or decrease migration trends, these future scenarios may provide some insight but have far more uncertainties when compared to other countries.



**Fig. 1.1** Population of Qatar (total), from 1990 to 2011 (World Bank, 2022)



**Fig. 1.2** Population of Qatar (total), monthly data from December 2010 to March 2022 (Planning and Statistics Authority, 2022)

Demographics matter when considering sustainability because many of the decisions we make today, particularly infrastructural, are intended to serve future populations for decades. This brief overview of demographics has only touched on the total population, but as Qatar aims to transition toward a knowledge-based economy, the types of expatriates living in Qatar will change, as will their needs and expectations. Ensuring that systems (e.g., transport, energy) are designed to meet those needs, while also transitioning to more sustainable ways of living, requires in-depth analysis. Indeed, this is one topic area we hope to see additional research on, particularly as it relates to the policy recommendations put forth in this collection (in the

following section we also note topics that are missing from this collection that we encourage more research to be conducted on).

The second area we highlight in this Introduction is the broader economy. Hydrocarbons are often focal to discussions of the economy, and rightly so, as they account for the majority of government revenue and export earnings. Several chapters in this collection focus on hydrocarbons (see chapter description in the section that follows), what we highlight here are other areas or aspects of the economy as we feel these are critical for the sustainability transition.

Connected to the hydrocarbon resources of the country, but less often covered, are domestic industries, including producing steel, fertilizer, and a range of petrochemicals (directly using hydrocarbons or enabled by them). The largest export, by value, other than petroleum gas, crude petroleum, and refined petroleum, is ethylene polymers, or plastic, followed by fertilizer (OEC, 2022). Other than natural resources-related industries (including the subsidiary industries noted above), the largest companies in Qatar (by value), according to Forbes (2021), are from sectors including finance (Qatar National Bank, Qatar Islamic Bank, Masraf Al Rayan, Commercial Bank, Qatar International Islamic Bank, Ahlibank, Doha Bank, Qatar Insurance Company, Qatar Development Bank, Dukhan Bank), construction and real estate (Ezdan, Barwa, Aamal, United Development Company, Qatar National Cement, Qatar Investors Group, Qatari Diar), telecommunications (Ooredoo, Vodafone Qatar), retail and consumer goods (Zad, Al Meera, Baladna, Mannai Corporation, Al Mana), healthcare (Medicare Group, Hamad Medical Corporation), hospitality (Katara, Al Fardan), and aviation (Qatar Airways). Qatar also has one of the world's largest sovereign wealth funds (Qatar Investment Authority). With the expansion of these companies domestically and internationally, the economy of Qatar is diversifying (albeit from a point of low diversification two decades ago to one relatively more diversified today). According to the Observatory of Economic Complexity (OEC) (2022), economic complexity dropped following the 2017 blockade of Qatar (for additional details on the blockade, see Chapters 2 through 6 in Alkhateeb, 2019, amongst others), before which it had a higher economic complexity than the UAE.

The State of Qatar has made major investments in infrastructure over the last two decades, including in ports, airports, subway and light rail, roads and highways, major city developments (e.g., Lusail), water desalination and distribution, all of which are estimated to be worth US\$ 300 billion by the Secretary-General of the Committee for Delivery and Legacy, Hassan Al Thawadi. Much of these investments have supported the growth of the above-mentioned companies and the diversification of the economy, utilizing hydrocarbon wealth to diversify the economy and enable the development of new industries. Qatar has established or has been working to develop niche industries, including in Islamic finance, tourism, sport, education, and healthcare. Such efforts, along with other government initiatives and policies to strengthen the economy (recent ones include enhancements to labor laws, the introduction of a minimum wage, changes to residency regulations, and foreign direct investment laws), appear to have yielded some progress in non-hydrocarbon sectors' performance (World Bank, 2021). The contribution of non-hydrocarbon

sectors, notably the services and construction sectors, has been significant to the GDP growth rate (e.g., between 2012 and 2021) when compared to hydrocarbons. Moreover, non-hydrocarbon economic activities' share in GDP has increased from 45% in 2013 to 63% in 2020 (Planning and Statistics Authority, 2021).

Aside from the above notes on economic diversification efforts and outcomes, future sustainability pathways require more than reducing the reliance on hydrocarbons and expanding the size of the remaining sectors in the economy. Future pathways call for more attention to enhancing and deepening adaptation and mitigation. Progress has been witnessed in several sectors, as highlighted by some chapters, such as in the construction, transportation, electricity supply, and waste management activities, in which a number of sustainable or eco-friendly reforms and practices have been introduced and implemented. Progress can also be noted in the academic realm that concerns the environmental impacts and recommendations or innovations to address them. Climate change's impact on the agriculture sector in Qatar, for instance, is increasingly highlighted in research (e.g., Ben Hassen et al., 2020; Karanisa et al., 2021, among many others). However, more effort is needed to understand how environmental degradation and climate change will affect the growth patterns of non-hydrocarbon economic activities in Qatar from one end and how these activities contribute to such challenges (their environmental footprint) from the other—and accordingly, interventions to address both. A sustainable transition, in many sectors, will require significant transformation, requiring flexibility and adaptability from the public and private sectors.

### 1.3 The Book

With the National Vision 2030 being launched in 2008, this volume provides an update on the key sustainability issues, focusing on environmental sustainability from a socio-political perspective. *Sustainable Qatar* has nineteen chapters, to which 39 authors contributed. One of the motivations for putting this book together was a recognition of experts within Qatar working on areas of sustainability, some of whom we knew before embarking on this book journey and others we met along the way. Of the 39 authors, 34 were based in Qatar at the time of writing, with many of the remainder previously having been based in the country. This is a testament to the commitment to research and sustainability in Qatar, as experts contributing to this book are affiliated with a wide range of institutions, including Hamad Bin Khalifa University (HBKU), Qatar University, Qatar Foundation, Texas A&M Qatar, Qatar Environment and Energy Research Institute, the Doha Institute for Graduate Studies, and the Supreme Committee for Delivery and Legacy.

When envisioning this project, we sought funding to make this book fully Open Access, which was provided by the Program on Governance, Resilience, and Sustainability, a research initiative within the College of Public Policy at HBKU. Being Open Access means that this entire book is freely available for students, researchers, decision-makers, and anyone else interested. As each chapter offers policy options

and recommendations, this was of fundamental importance since most policymakers often do not have access to costly academic publications. Being Open Access ensures that access to evidence is not a barrier in the decision-making process.

While we are excited that this book came together with nineteen chapters, we also recognize that there are some issues that are not covered, or not sufficiently covered. For a book offering policy implications, and one that emphasizes the interconnectedness of the issues covered, these omissions are important to make note of. From our perspective, some of the key missing topic areas include domestic transportation, aviation, international shipping and global supply chains, the built environment, marine biodiversity, cooling systems, desalination processes, demographics, inequality, gender, and other forms of social differentiation with regard to impacts of sustainable transitions, migration, health, and tipping point emergency planning. We hope that researchers will continue to make contributions to advance the evidence base supporting the sustainability transition in these, and other, areas.

## 1.4 Chapters

The final section of this Introduction presents a chapter-by-chapter review of the book, highlighting some key components that stood out for us as editors. The book begins with two chapters on the strategic and legal aspects of sustainability. In Chapter 2, Reem Al-Hababi tracks how environmental sustainability policy has developed in Qatar through surveying the key guiding policy documents, regulations, and institutions that concern environmental affairs. The chapter argues that while progress toward Qatar's environmental sustainability targets has been modest—many of the targets are quite ambitious—the policies have improved. Pending, however, is a detailed assessment of the institutions and laws/policies to meet and uphold these targets. To date, assessment and public reporting have been limited. On this basis, the chapter concludes that future efforts should focus on the microlevel in order to enhance institutional and technical capacities. The chapter also argues that more attention should be paid to evaluation and monitoring so as to address the persistent challenge of limited data about ecological systems. Transparency of such data would alleviate the ambiguity of the strategies' actual outcomes.

Chapter 3, by Damilola Olawuyi and Elena Athwal, narrows the focus from vision and strategy to laws and regulations. The chapter discusses the legal and governance frameworks that are in place to address sustainability and energy transition challenges. Damilola and Elena highlight how engaging in regional and international sustainability frameworks has contributed to the integration of environmental considerations in Qatar's national policies and how environmental preservation and energy transition have been at the core of a wide range of primary and secondary laws. Based upon this analysis, the authors note limitations within existing frameworks on sustainability due to the governance approach, particularly in terms of coordination and cooperation among relevant actors in delivering sustainability projects and programs, as well as the lack of knowledge and information sharing between

them. The chapter suggests that there is a need for a nexus governance approach and dynamic legal innovations to enhance the coordination and coherent implementation of Qatar's rapidly increasing number of sustainability policies, laws, and organizational bodies. It also suggests the need to create an oversight body, considering the increase in spending on sustainability initiatives in Qatar, to monitor and evaluate the implementation of these initiatives in a measurable way in order to ensure real progress is made. In line with Chapter 2, Damilola and Elena highlight the critical nature of data sharing.

FIFA 2022 is a major event for a country the size of Qatar (geographically and demographically), and this international sporting event had the potential to be a catalyst for change, given how substantial the changes would be to prepare for it. In Chapter 4, Orjan Lundberg discusses how winning the bid to host the international tournament has acted as a motivator for Qatar toward achieving environmental sustainability throughout the preparation and delivery stages of the event, and the legacy that it intends to leave behind. The chapter highlights the environmental issues that usually accompany hosting such sports mega-event and the responses that the organizing entities have identified to address them. Orjan argues that such sports mega-events can serve as a platform to shed light on global environmental challenges and that hosting such events can provide an opportunity for the hosting country to catalyze a positive, sustainable development with the infrastructure, technology, skills, and supply chains that develop toward and throughout the event. Akin to Chapter 3, this chapter calls for an overarching entity that ensures cohesion across all activities and institutionalization for the future.

The Supreme Committee for Delivery and Legacy was established by the State of Qatar and leads all FIFA-related activities. While wielding significant influence between 2010 and 2022, Chapter 5 looks at a non-governmental actor working over the long term to push for sustainability innovation. Authored by Fahad Al-Musalmani and Sylvie Maalouf, the chapter presents a detailed analysis of Qatar Foundation's experience and journey as a non-state actor contributing toward environmental sustainability and the various initiatives and programs that it has developed and carried out. Fahad and Sylvie show the role non-governmental actors can play in promoting sustainability through formal and informal means, such as via education, research, advocacy, and piloting innovative solutions, thereby setting the example for other entities to undertake similar paths. This chapter concludes saying that Qatar, due to its being on the receiving end of many of the adverse effects of climate change and its influence on the global energy sector, is uniquely positioned to lead the global sustainability movement, something the authors argue the Qatar Foundation is at the forefront of as a result of its integration of research, education, and civil society.

Shifting to the key economic sector of Qatar, Steven Wright looks at the energy sector as Qatar engages with a global transition toward renewable and carbon-neutral energy futures. Chapter 6 evaluates Qatar's sustainability challenge, as a country reliant on the gas sector. The assessment also takes into account geopolitical shifts, which do not all necessarily push for decarbonization, such as the rise of demand for LNG from Qatar following Russia's invasion of Ukraine. Natural gas is viewed as low-carbon energy (transitional), which means that global demand is expected



to last for some time. Domestically, gas sector revenues are needed to carry out the development plans and projects (including those intended to assist diversifying the economy and enhancing other sectors' contributions), which means that the gas sector must be able to adapt to the challenges and changes in geopolitics. Steven argues that the way forward toward sustainability requires enhancing the gas sector's ability to adapt to challenges and changes in energy markets by "maximising the relevancy, innovation, and economic returns" within and beyond the sector. The sector's future growth and development rely on progress at several forefronts, including reducing the gas sector's environmental footprint (through, for example, the deployment of carbon capture and storage technologies), increasing renewable energy capacity, and investing in "blue" and "green" hydrogen and ammonia sectors.

Turning to Chapter 7, Sara Al-Mohannadi and Dhabia Al-Mohannadi outline the challenges and opportunities of transitioning to a low-carbon economy, and particularly within the energy sector. The transition away from fossil fuels will ultimately expose Qatar to market vulnerabilities, but outline that there are ways to make this transition successfully. Building on the chapter by Steven Wright, these authors explore the implications for Qatar's energy sector in the medium and long term and the need to enhance the hydrocarbon sector's adaptability to gradual changes in energy demand. The chapter suggests that the adaptability and sustainability of the energy sector can be improved through the deployment of carbon capture storage and renewable energy technologies. Sara and Dhabia note the potentials that might exist in emerging markets, such as liquified hydrogen, and the option of investing in such sub-sectors, especially since Qatar has an advantageous position being one of the leading gas exporters worldwide.

In Chapter 8, Marcello Contestabile highlights the "systemic nature of sustainability policy problems faced by Qatar." The main systemic challenges mentioned by the chapter include moving away from the rentier-state economic model and the requirements, implications, and risks of such economic transition from social, environmental, and economic respects. The chapter argues that the multidimensional nature of sustainability challenges requires a systems perspective. Types of systems analysis tools are presented in the chapter along with a description of their key purpose and characteristics. Though there is a wide range of system analysis' frameworks and tools, the chapter highlights that the complexity of sustainability issues can be better addressed through a combination of them in which one tool or framework complements the others. The role of Qatar Environment and Energy Research Institute in establishing systems models is discussed along with the Institute's current key project, the Integrated MARKAL-EFOM System, which is intended to support policy analysis and making in Qatar. The chapter concludes that future efforts to support sustainability should include raising awareness among policymakers and various stakeholders about the potencies of the systems approach and the necessity of establishing its relevant tools in guiding policymaking and the prospects of such evidence-based policies that concern the complex challenges of sustainability.

Chapter 9 begins to look at the impacts of climate change on Qatar, and specifically how sea-level rise will affect the region in the coming decades, highlighting how this poses a national security risk that needs to be on top of policy agendas across the region. Laurent Lambert and Cristina D'Alessandro warn of the risks of the poorly

documented hazards of sea-level rise on coastal cities in the Middle East and North Africa. Notably, the risks associated with sea-level rise are not limited to sea-level rise itself but are also associated with increases in extreme weather events, storm surges, and other coastal hazards. Coastal cities in the region are characterized by high population density and their significance to the states' economy. The authors suggest that technological solutions must be selected and appropriately used on a case-by-case basis; one solution will not fit all countries facing the challenges of sea-level rise. Laurent and Cristina argue that state and city leadership, alongside diverse stakeholders, are needed to ensure that the measures selected to address the challenges posed by sea-level rise are appropriate to the cities and their communities. The chapter examines the efforts made to adapt to sea-level rise and their relevant challenges in Doha as a study case. The main challenges highlighted in the chapter include the lack of transparency with stakeholders in terms of communicating the necessity to maintain a balance between mitigating risks and stimulating economic activities in coastal cities and the limited institutional capacity for sustainable urban planning (also highlighted in Chap. 3).

Chapter 10 is concerned with Qatar's marine biodiversity, particularly the impact of rig-to-reef processes—throughout the decommissioning of offshore oil platforms—on marine ecosystems. To investigate this, Radhouane Ben-Hamadou, Ahmad Mohamed, Sarra Dimassi, Mariem Razavi, Sara Alshuiael, and Muhammad Sulaiman apply a systems analysis (Driver-Pressure-State-Impact-Response) to understand the implications of such an approach. The chapter highlights that offshore oil and gas platforms have actually provided a habitat for many marine species and have assisted in increasing marine biodiversity. Accordingly, such manmade structures have been useful to marine systems during their “design life” and, therefore, should be preserved by “converting them into artificial reefs under rig-to-reef programs.” Various methods of rig-to-reef are indicated along with the benefits of them, which include creating, restoring, and preserving marine habitats. On the other hand, the success of these methods, as outlined by the chapter, is associated with numerous aspects that are divided into technical factors (which relate to, e.g., water depth, geographic location, geological conditions) and non-technical factors (which relate to climate change impact, i.e., increase in temperature), in addition to legal and technological factors. Future pathways for successful rig-to-reef application and protected marine environment following the decommissioning of offshore oil and gas platforms, as per the authors, revolve around establishing “a consistent policy and regulatory framework” concerning the marine habitats surrounding oil and gas sea facilities, “clear and defined liability and compensation schemes” for relevant stakeholders, and implementation of assessment and monitoring programs.

Jenny Lawler, Annamaria Mazzoni, and Sa'd Shannak turn to another aspect of water: the domestic water system. Given that Qatar has almost no freshwater resources (limited to groundwater resources), the water sector is of critical importance for the country. In Chapter 11, the authors argue that as Qatar continues to develop and become self-sufficient, the population grows there will be increased strain on water resources. As a result, they suggest that sustainable solutions need to be implemented that include all key stakeholders in the water sector. They additionally suggest that “water management can be approached from an allocation efficiency perspective, as

well as from a societal point of view in terms of quantity and access” and highlight the importance of monitoring and regulation enforcement. Analyzing supply- and demand-side factors, the chapter highlights that the strategies that concern future water sustainability pathways should integrate water quality and quantity monitoring and assessment systems and should align with food security strategies to maximize the outcomes of both.

In Chapter 12, Sana Abusin, Ebaidalla Ebaidalla, and Maryam Al-Thani draw upon their previous research on food loss and food waste in the State of Qatar and highlight one of the emerging options to reduce loss and waste, specifically focusing on the role of non-governmental organizations in reallocating these resources. The authors argue that there needs to be greater cooperation between all key stakeholders (government, non-governmental organizations, charities, academics, private companies) in order to strengthen food insecurity while in tandem reducing food loss and waste. Sana, Ebaidalla, and Maryam suggest that this includes further involving non-profit organizations to engage in waste management and food management, through which resources may be redistributed to those in need of them, preventing forms of food loss and waste while addressing food insecurity. For foods that cannot be redistributed, the authors argue it is critical to segregate organic waste so that it can be composted and create new value (and not sent to the landfill, creating costs).

April Torres Conkey, Cromwell Purchase, Renee Richer, and Nobuyuki Yamaguchi turn our attention to terrestrial biodiversity in Chapter 13. Although not a place known for its biodiversity, given its arid climate, the authors argue that Qatar’s arid environment has great biodiversity despite its largely unstudied/understudied nature; a biodiversity they believe will provide the nation with immense biological resources essential to enhancing resilience to climate change. The chapter provides a readable overview of the various plants and species that are specific to Qatar’s hyper-arid ecosystems and highlights their importance for climate change resilience, and notes that although Qatar’s environment has “a wide range of communities and organisms from microbials to plants and animals,” they remain understudied. The authors’ recommendations include developing databases and conducting periodic surveys to monitor the ecosystems and their inhabitants’ status and establishing guidelines for land use and agricultural or grazing practices to reduce their negative impacts on natural habitats.

Qatar is an urban country, with an estimated 99% of its population living in urban areas (primary the capital city and surrounding areas; World Bank, 2022). Chapter 14, written by Velina Mirincheva, Jason Twill, and Nihal Al-Saleh, presents an argument for thinking about 15-min cities, taking Doha as an example (and highlighting emergent examples of this form of urban development). The chapter highlights how the 15-min city concept revolves around “fulfilling the essential social urban functions” and addressing urban challenges that relate to “(a) density, (b) proximity, (c) diversity, and (d) digitalization.” The chapter provides an examination of Doha City and whether it can be transformed into a 15-min or “compact, density-balanced city.” For a city that is quite dependent upon personal vehicles (despite a new subway system, multiple tram systems, and a public bus system), Velina, Jason, and Nihal argue for

a reconceptualization of lifestyles and urban living, one which enhances well-being and sustainability.

Chapter 15, by Esmat Zaidan, also concerns sustainable urban planning. The chapter sheds light on the concept of smart sustainable cities in the Gulf's "Post-Oil" context and the drivers and requirements for their creation. Establishing an effective zero-carbon strategy, as per the chapter, is crucial for achieving smart sustainable cities and requires assessing the socioeconomic factors that contribute to the transformation to a zero-carbon community comprehensively. The challenges of smart sustainable cities' strategies and projects in the Gulf region, as a whole, and in Qatar that are highlighted by the chapter include the orientation of past and existing infrastructure planning, which has lacked consideration for the interdependencies between various sectors and long-term needs. Other challenges identified include the resistance to implement smart sustainable cities' strategies and solutions by relevant stakeholders due to a lack of awareness about the interlinkage and interplay between their sectors. The way forward, according to the chapter, involves a comprehensive national strategy for urban planning that is articulated based on a thorough understanding for the society in Qatar and inclusion of socioeconomic and behavioral dimensions, effective engagement and collaboration of stakeholders, and sound regulations and legal framework for the information, communication, and technology sector.

While noted by other authors in brief, Husameldin Mohamed Talballa Elshaikh and Jonathan Gichuru turn our attention to an aspect of sustainability often forgotten: waste management. In Qatar, this is particularly important, as the country has high per capita waste generation, and expectations for the waste generation to rise with population growth and continued economic development. Chapter 16 discusses the strengths and weaknesses of the waste management sector and how non-hazardous solid waste is handled in Qatar. The chapter sheds light on various stakeholders' efforts toward sustainable waste management, including a case study of Qatar University's zero-waste initiative. The case study showcases a holistic approach with a variety of policy tools, active engagement of actors and stakeholders, and public participation, which are among the recommendations the chapter has identified to reduce generated waste and improve waste management processes. Drawing on the example, the way forward for Qatar includes establishing an integrated approach (top-down and bottom-up) with a mix of policy instruments, engaging actors and stakeholders, public-private partnerships and collaborations, the establishment of zero-waste frameworks, and behavioral change (which can be achieved through centralizing public participation in the efforts made).

In Chapter 17, S. Duygu Sever and M. Evren Tok explore how broader societal attitudes can change, in looking at education for sustainable development in Qatar. The authors explore how sustainable development is integrated into the educational system in Qatar, whether in the formal or informal means, by examining the relevant policy documents, initiatives, and actors. The chapter highlights the important role the education system plays in building knowledge, skills, competencies, and mindsets of future generations to carry out the sustainability efforts further. The way forward, as per the chapter, includes a defined, explicit action plan that integrates education

for sustainable development into all educational levels and the whole curricula, as well as improved access to sustainability development-specific teaching methods and innovations for educators and students.

The second last chapter of this collection, Chapter 18 by Tarek Ben Hassen, discusses the transition from a rentier-state economic model to a more sustainable, knowledge-based resilient economic model with a special focus on the entrepreneurial ecosystem in Qatar and how it can be enhanced to stimulate such a shift. The chapter argues that Qatar's knowledge-based economic sector growth faces many challenges due to its status as a rentier state. These challenges are (1) as in a rentier state, the government is the primary employer many people are not currently considering a future in STEM, hindering entrepreneurship abilities; (2) the passive entrepreneur is the most popular type of entrepreneur, with many having companies on the side of their full-time job in the public sector to provide additional income while still holding a steady job; (3) there is a lack of access to finance for entrepreneurs due to the culture surrounding Qatari banks. Tarek concludes by arguing that Qatar's transition toward a more knowledge-based economy will require participation from all stakeholders and a national plan that avoids a silo mindset. He also suggests that export and activity diversification could help along with the implementation of sector-specific policies.

Chapter 19, the Conclusion by Leslie Pal, Logan Cochrane and Reem Al-Hababi, attempts to offer a reflection on the book chapters by providing a brief on the sustainability context in Qatar, the policy frameworks, their implementation, and the key recommendations for future pathways. The chapter also highlights sustainability topics that are missing from this volume.

We hope that you, the readers of this collection, find this book a useful source of diverse issues and perspectives. We believe the range of opinions found within this collection reflect the wide range of options and pathways available to the State of Qatar, and it is, for this reason, we encouraged authors to write as they felt best appropriate, rather than according to a pre-determined framework that all issues ought to fit within. We greatly look forward to ideas and discussions that emerge following the publication of this book.

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