UN environment programme

Waste Management Outlook for WEST ASIA

2019

WASTE TO WEALTH

ISWA International Solid Waste Association

IETC Technology for Environment INTERNATIONAL ENVIRONMENTAL TECHNOLOGY CENTRE

CEDARE

Copyright © United Nations Environment Programme, 2019

Reproduction
This publication may be reproduced in whole or in part and in any form for educational or non-profit purposes without special permission from the copyright holder, provided acknowledgement of the source is made. The United Nations Environment Programme would appreciate receiving a copy of any publication that uses this publication as a source. No use of this publication may be made for resale or for any other commercial purpose whatsoever without prior permission in writing from the United Nations Environment Programme.

Disclaimer
The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the United Nations Environment Programme concerning the legal status of any country, territory, city or area or of its authorities, or concerning delimitation of its frontiers or boundaries. Moreover, the views expressed do not necessarily represent the decision or the stated policy of the United Nations Environment Programme, nor does citing of trade names or commercial processes constitute endorsement.

Mention of a commercial company or product in this publication does not imply endorsement by the United Nations Environment Programme.

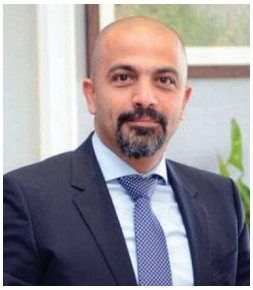
ISBN No: 978-92-807-3767-7
Job No: ROW/2264/BA

Suggested citation:
UN Environment Programme (2019). Waste Management Outlook for West Asia.

Credits
© Photos, and illustrations as specified.

*The **International Environmental Technology Centre***
works with developing countries to implement
sustainable solutions to environmental challenges,
with focus on holistic waste management.

Foreword



I am delighted to introduce to you the first Waste Management Outlook for the West Asia region. It follows and complements the Global Waste Management Outlook published by UN Environment Programme in 2015 and a series of regionally focused Waste Management Outlooks. These Outlooks serve as one of the tools for policy makers, academia and civil society to help and guide them toward the sustainable and integrated management of waste.

The West Asia region includes twelve countries with unique and distinctive waste management needs. For instance, conflicts throughout this decade have had a severe impact on the environment. Countries in the Region suffer from increasingly severe climatic conditions and poor waste management systems. Common throughout the world is the need for a sustainable waste management system that incorporates a profound shift from the current "linear" economic model to a circular economy development model that reduces waste prior to its generation, reuses it or recycles it, returning it to the supply chain to deliver social, economic and environmental benefits.

The Waste Management Outlook for West Asia gives an overview of the current waste management situation in the region and analyses potential solutions to current waste management issues. The rise in population from 99 million in 2000 to 155 million in 2016 and the increased exploitation of resources are the main drivers of these waste management challenges. In 2016, while the municipal solid waste generated was estimated at 60.4 million tons, only 11% of the waste generated was treated. The treatment capacity deficiency, estimated at 46.4 million tons of waste, can be developed to create revenues through the use of the proper waste collection, treatment and disposal management systems. The life cycles of products should be fully utilized to minimize the waste and emissions generated. It is also crucial to mention that untreated waste ultimately has a great impact on the health of the population.

This Outlook for West Asia sets out a future progression of sustainable waste management that will enable the region to transition from one dependent on the low cost of dumping waste to one utilizing waste as a resource. The Outlook is set within the context of driving regional economic growth and the development of a range of investment opportunities in waste management services and added value circular economic activities. To support this, it proposes new methods to deal with waste treatment in a sustainable framework.

The Waste Management Outlook for West Asia is a 'Regional Outlook' commissioned by UN Environment Programme's West Asia Office in partnership with the International Environmental Technology Centre (IETC), the Centre for Environment and Development for the Arab Region and Europe (CEDARE) and the International Solid Waste Association (ISWA). I wish to express my gratitude to these three partners in particular and indeed to everyone who contributed to the compilation and publication of the Outlook.

Sami Dimassi

Director and Regional Representative
UN Environment Programme West Asia Office

Acknowledgements

The following report is the result of a joint effort between the United Nations Environment Programme (UN Environment Programme) and the Centre for Environment and Development for the Arab Region & Europe (CEDARE), in the Arab Region, Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, State of Palestine, Qatar and the United Arab Emirates.

Core Team:

Lead Author and Editor

Paul Dumble (Independent Waste Specialist, Paul's Environment Ltd, United Kingdom)

Co-Authors

Dr. Ihab Tarek (Ph.D, International expert on environmental legislation, Ex-Environment Governance Regional Coordinator at UN Environment Programme, Appeal Court Chief in Egypt), Abdul-Sattar Nizami (Ph.D, Assistant Professor & Head of Solid Waste Management Unit, Center of Excellence in Environmental Studies (CEES), King Abdulaziz University, Kingdom of Saudi Arabia)

Authorship of the eight chapters

Chapter 1: Introduction

Ihab Tarek, Abdul Sattar Nizami and Paul Dumble

Chapter 2: Status of the Region in Waste Management

Abdul Sattar Nizami and Paul Dumble

Chapter 3: Special Regional Features

Abdul Sattar Nizami and Paul Dumble

Chapter 4: Waste Governance

Ihab Tarek and Paul Dumble

Chapter 5: Technologies, Waste Systems and Operations

Paul Dumble

Chapter 6: Business and Economic Opportunities in Waste

Paul Dumble

Chapter 7: Sustainable Development Goals

Paul Dumble

Chapter 8: The Way Forward

Ihab Tarek and Paul Dumble

Project Management Team

UN Environment Programme Project Coordination

Abdul-Majeid Haddad (Deputy Regional Director), Iyngararasan Mylvakana (Programme Officer)

CEDARE Project Coordination

Hossam Allam (Regional Programme Director), Ghada Moghny (Programme Coordinator), Terry Fahmy (Regional Programme Specialist), Rym Hazem (Programme Assistant), Lamia Nabil (Communication Consultant)

Special Acknowledgements

Peer Reviewers

Dr. David C. Wilson (Independent Waste and Resource Management Consultant, Visiting Professor in Waste Management at Imperial College London, UK), Dr. Linda Godfrey (Manager, Waste RDI Roadmap Implementation Unit, DST, Principal Scientist, Waste for Development, CSIR, Extraordinary Associate Professor, North-West University, South Africa), Dr. Prasad Modak (Executive President, Environmental Management Centre LLP, Mumbai, India), Prof. Agamuthu Pariatamby (Editor in Chief - Waste Management & Research, Editor in Chief- Malaysian Journal of Science, Head-Center for Research in Waste Management, Professor - Institute of Biological Sciences, Faculty of Science, University of Malaya, Malaysia), Dr. Otto Simonett (Director, Zoi Environment Network, Switzerland), Mr. Arne Ragossnig (Managing Director, International Solid Waste Association [ISWA]), Mohamed Tawfic Ahmed (PhD [London] DIC, Professor of Environmental Toxicology, Suez Canal University, Egypt)

Production Team

Mohamed Aman (Bahrain), Firas Shehab (Iraq), Hajar Majar (Jordan), Abdullah Al Otibi (Kuwait), Ali Mroweh (Lebanon), Ahmed Al Zadjali (Oman), Dalia Al Asmar (Palestine), Hamad Jassim Al-Bahar (Qatar), Arwa Rashed (United Arab Emirates)

Special thanks to our UN Environment Programme colleagues, in particular to:

Fareed Bushri and Nagwa El-Karawy, for their valuable efforts, collaboration and support.

Special thanks to our ISWA colleagues, in particular to:

Aditi Ramola, for her substantive contribution and valuable input toward this report.

International Solid Waste Association
General Secretariat
Auerspergstrasse 15, Top 41, 1080 Vienna, Austria
Tel.: +43 1 253 6001 Fax: +43 1 253 6001 99
Email: iswa@iswa.org Web: www.iswa.org

Copy Editor: Tara Cannon

Design and layout: Mohamed Solyman, Yasser Hamdy

Contents

List of Tables

List of Figures

Executive Summary

The Waste Management Outlook for West Asia was commissioned by the UN Environment Programme West Asia Office in partnership with the Centre for Environment and Development for the Arab Region and Europe (CEDARE), the International Environmental Technology Centre (IETC) and the International Solid Waste Association (ISWA). West Asia refers to the twelve countries and territories of Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, the United Arab Emirates (UAE) and Yemen.[1] The region's unique cultural and religious perspectives and climate conditions create significant challenges for waste management.

This Regional Outlook builds upon the Global Waste Management Outlook published in 2015. Focusing on waste management systems, finance and governance, it articulates a means of future progress toward sustainable waste management to enable a transition from a region historically dependent on the low cost of dumping waste to one utilizing waste as a resource. To visualize this process, the Regional Outlook highlights the potential of the circular economy, in which waste serves as a resource and as a driver of regional economic growth through multi-stakeholder involvement, creating a range of funding and investment opportunities.

The countries of West Asia have been beset directly and indirectly by a period of ongoing conflict that is largely being brought under control. The international community is likely to respond to the aspiration of a peaceful, safe, healthy and vibrant environment that incorporates the future development of waste management in a way which encourages regional growth and development by addressing the objectives set out in the Sustainable Development Goals (SDGs), the United Nations blueprint to achieve a better and more sustainable future for all. Between US$50 and $150 billion in international aid may be generated for reconstruction and infrastructure development, in which sustainable waste management initiatives have a critical role to play.

This Regional Outlook sets out a comprehensive view of the current situation across the region, where pressures for sound waste management have increased as the population has grown from 99 million in 2000 to 155 million in 2016, with the proportion of urban residents increasing from 63% to 70%. Municipal solid waste was estimated at about 60.4 million tons in 2016, with the informal sector collecting an estimated 7.1% of this and about 16.8% remaining uncollected. An estimated 87.4% of all municipal solid waste goes to land disposal. Of this, 39.5% goes to uncontrolled dumpsites. The waste treatment level is about 11.0%, with sanitary landfills accounting for roughly two-thirds of the treated waste. The overall deficiency in waste treatment capacity is 46.4 million tons. Other annual waste streams assessed include 71 million tons of construction and demolition waste.

A sustainability assessment framework was used to develop intervention scenarios that will achieve the Sustainable Development Goals related to waste. However, 2020 targets may be difficult or unachievable for the middle-income countries of the region without the cessation of conflict and immediate, international assistance. An assessment of governance measures addressing and implementing sound waste management practices identifies actions for the effective implementation and enforcement of international treaties and conventions by each country. As plastic businesses contribute 40% to 45% of GDP in most Gulf Cooperation Council (GCC) countries (Source: GPCA 2014), it is important that governments demonstrate to the world that plastics are valuable materials able to be responsibly managed in ways that do not contaminate marine or land environments.

[1] When we refer to "12 countries" in this report, we are referring to 11 countries and the territories designated as the State of Palestine. For the purposes of this Regional Outlook, all 12 will be referred to as "countries."

Future annual waste management budgets may need to increase from the current estimate of US$3.6 billion (0.2% of regional GDP) in order to develop basic to fully integrated waste management options, increasing to a budgetary demand of US$4.4 to $7.9 billion (0.3% to 0.5% of GDP). Shared equity and risk-based public-private sector procurement are discussed as ways of generating an estimated US$10 billion (or more) annually from value-added enterprises utilizing waste as a resource. This requires investment in smart waste systems and treatment technologies that maximize the return of value-added raw materials and products to the supply chain from recyclables and organic residuals.

GCC countries can establish high-value integrated waste management options within the affordability criteria limits of 0.6% to 1.0% of GNI per capita (Source: GWMO by WB). However, middle income countries using the threshold of 0.3% to 0.6% of GNI per capita criteria will require international assistance to establish the infrastructure, capacity and necessary capability to create opportunities that will foster further economic growth through a circular economy. The costs for additional integrated waste management treatment and disposal costs could be reduced, eliminated or made economically viable by adopting non-thermal drying technologies, processing segregated food wastes with agricultural wastes to produce high-value soil supplements and generating high-value biochar, biofuel, biochemicals and power from residual organic wastes.

Table 1: Integrated waste management affordability ranges and options in West Asian countries

	Integrated waste management affordability range				**Integrated waste management options**	
Country	**1% GNI/capita (US$)**	**0.6% GNI/capita (US$)**	**0.3% GNI/capita (US$)**	**Current systems (2016) (US$/inh)**	***Sanitary landfill (US$/inh)**	***Integrated waste management drier options (US$/inh)**
West Asia countries	115.4	69.3	34.6	23.4	28.2	37.8-50.2
GCC countries	270.5	162.3	81.2	30.6	37.5	50.2-66.7
Bahrain (all wastes)***	210.9	126.6		31.0	98.3	131.5-174.7
Iraq		29.1	14.5	25.2	**31.9**	**42.7-56.7**
Jordan		24.3	12.2	21.6	**24.1**	**32.3-42.9**
Kuwait	348.9	209.3		27.0	29.9	40.0-53.1
Lebanon		47.0	23.5	29.5	30.1	**40.3-51.5**
Oman	171.6	103.0		36.6	38.7	51.8-68.7
Palestine		19.7	9.9	**29.2**	**29.3**	**39.2-52.1**
Qatar	730.6	438.4		38.1	33.9	45.4-60.3
Saudi Arabia	208.3	125.0		27.6	35.9	48.0-63.8
Syria**		13.0	6.5	**15.7**	**18.6**	**24.9-33.1**
UAE	378.5	227.1		37.9	45.5	60.9-80.9
Yemen**		5.9	3.0	1.9	**12.4**	**16.6-22.0**

Bold Black indicates exceedance of affordability limits
* May be up to 25% higher due to the cost of finance
** Figures may be overestimated due to ongoing conflict
*** Includes both household waste and other wastes taken to the Askar dumpsite in Bahrain

Source: Compiled by Author

Cost internalization policies through the use of tariffs and extended producer responsibility will be essential to ensure ongoing stable financing for waste collection services, the operation of essential waste management services and support in the financing, maintenance and operation of integrated waste management facilities.

Advances in waste treatment technologies and current market conditions affecting recyclables are expected to give rise to significant investment opportunities resulting from coordinated regulatory and fiscal developments. These changes are also expected to incentivize working with the entrepreneurial private sector to provide economically viable treatment technologies that will return waste as raw materials for new enterprises across the region.

Residual municipal solid waste organic fraction for composting. Could there be better treatment options for the organic fraction? (Source: Author)

INTRODUCTION

CHAPTER

Key messages

Historical and current waste practices have resulted in environmentally damaging pollution and emissions. West Asian countries are aware of and responding to these challenges. Progress will be dependent on building key stakeholder relationships and on adopting and implementing key sustainability concepts and policies while focusing on major development themes across the region.

Outlook

Chapter 1 presents the context, scope, concerns and limitations of this Waste Management Outlook, delivering an overview of the political and socio-economic context in alignment with global strategies, sustainability concepts and themes, and priority issues. This section introduces the themes and conceptual tools that will be developed throughout the document.

The Waste Management Outlook for West Asia is a regional outlook commissioned by UN Environment Programme's West Asia Office in partnership with the Centre for Environment and Development for the Arab Region and Europe (CEDARE), the International Environmental Technology Centre (IETC) and the International Solid Waste Association (ISWA).

This Regional Outlook is based on the Global Waste Management Outlook (UNEP/ISWA 2015), which focuses on integrated waste management systems, finance and governance. This Outlook for West Asia sets out a future progression of sustainable waste management that will enable the region to transition from one dependent on the low cost of dumping waste to one utilizing waste as a resource. The Outlook is set within the context of waste serving as a resource and driving regional economic growth through the development of a range of investment opportunities.

Waste management in the West Asia region has been characterized by high levels of disposal, mainly in unlined sites known as dumpsites (UNEP 2016). Such disposal sites are often located within communities or around their perimeters, resulting in harmful emissions and leachate, with particulates from open burning that are likely to have severe health impacts on effected communities (as identified in Lebanon by Baalbaki et al. 2016).

Moving from waste management to resource management

Until relatively recently, waste management in West Asian countries has been based on linear models of "collect and dispose" or a limited version of the "waste hierarchy". Countries across the Middle East aspire to the "Full Cycle" which is known as the circular economy. Solutions focused on the "3Rs" of "reduce," "reuse" and "recycle" at the top of the hierarchy are prioritized, and any recyclable that emerges is linked into the resource and product supply chain. Extending the hierarchy to include both non-hazardous and hazardous waste leads to a regulatory framework shown in Figure 1. Further details can be found in Lansink (2017) and the Global Waste Management Outlook (UNEP/ISWA 2015).

Figure 1: Extended waste hierarchy and the regulatory framework adopted in Europe

Tools for Integrated Waste Mangement and the Circular Economy

Adapted Waste Hierarchy Regulatory Framework (European)

REDUCE:	Waste Prevention
REUSE:	Re-use and maintenance of products
RECYCLE:	Collection, sorting and re-use of materials
ENERGY:	Stabilization of carbon, biochemical and energy recovery*
STABILIZATION:	Strong of organic carbon, containment of toxic wastes
INCINERATION:	Incineration as disposal
LANDFILL:	Sanitary including landfill gas energy recovery or flaring
LAND DISPOSAL:	Dumpsites (unlined managed or unmanaged)

Notes: *"Energy recovery," classified in terms of efficiency of highest levels of electricity and heat recovery, refers to the incineration with no energy recovery.

Source: Adapted from the European Commission Regulation (Legal) Framework for Waste[2]

The waste hierarchy helps to reduce toxicity while also minimizing the biodegradable organic content of the finally disposed waste. These aspects have been key in achieving European regulatory objectives.

[2] For further information on developing European waste regulatory frameworks, please refer to Ad Lansink (2017, 55-98 & 317-347).

Zero Waste and Cradle to Cradle

Regulatory systems may be supported by strategies known as "Zero Waste" or "Cradle to Cradle." "Zero Waste" is about reducing and eliminating waste going to land disposal sites; "Cradle to Cradle" is about returning the used products or recyclables back to the supply chain, with these strategies overlapping.

These strategies may be competitive, so for example, plastics that have high calorific values are often required to support waste-to-energy options, in competition with plastic collected for recycling schemes. Both strategies have their merits, so often it is a matter of optimizing and comparing the socio-economic and environmental benefits from the proposed range of technical solutions.

The circular economy

The circular economy begins with the design of the product or service that is produced from or uses raw materials in a manufacturing or service delivery process. These products and materials are used or commissioned by or sold to consumers until they are discarded and become waste. Consumers are simply those that use raw materials, services or products that will in part or wholly become waste. For the circular economy to work, the consumer must maintain the product and/or return the waste, making use of available recycling collection services.

Historically, most of the waste entering the circular economy in West Asian countries has been collected by the informal sector. For example, in Jordan an estimated 10% of municipal waste quantities (Aljaradin et al. 2015) or in Lebanon up to 20% of Beirut's municipal waste stream is collected as recyclables by the informal sector (CDR 2015).

Waste management as a starting point for sustainable development

Waste management represents a resource hub by returning wastes as recyclables to the supply chain as raw materials. Sound waste management is also a means of mitigating greenhouse gas emissions. Both of these aspects are key elements supporting sustainable development. The United Nations has established the UN Sustainable Development Knowledge Platform (2017), which is used by 11 of the 12 West Asian countries.[3, 4] This web platform includes attachments of country reports on topics such as their degree of attainment of the Sustainable Development Goals, which set out waste priorities and targets. The relationship of waste targets to the Sustainable Development Goals is more fully explained in the Global Waste Management Outlook (UNEP/ISWA 2015) and will be developed in this Regional Outlook in chapter 7.

Overall aims

The aims of this Regional Outlook are:

- to analyse the current situation of waste management in countries in the West Asia region,
- to propose a way forward within the Regional Outlook to support improved resource and waste management,
- to make recommendations based on identifying pathways and building partnerships to foster progress toward the adoption of sustainable waste management systems that will maintain peace, prosperity and sustainable development in the region into the future and
- to build awareness of crucial waste management issues and opportunities among key policy and decision makers.

[3] When we refer to "12 countries" in this report, we are referring to 11 countries and the territories designated as the State of Palestine. For the purposes of this Regional Outlook, all 12 will be referred to as "countries."

[4] The Palestinian State is not included in the Sustainable Development Goal Knowledge Platform.

Specific objectives

The principal objectives of this Regional Outlook are to review the current situation of waste management activities in West Asian countries:

- to set out the case for integrated waste management in order to improve public health and the environment,
- to set out systems to enhance resource efficiency and implement sustainable resource management measures and
- to provide recommendations for improvements to institutional governance, financing, building stakeholder partnerships and procurement.

Defining the scope and coverage of the Regional Outlook

The 12 countries in this Regional Outlook are covered by UN Environment Programme West Asia Office. These are in the Mashreq region Iraq, Jordan, Lebanon, Palestine, Syria and Yemen, together with the six Gulf Cooperation Council countries of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

All human activities generate waste. This Regional Outlook will not only offer ways of creating added value for waste but also highlight ways of creating revenue to develop the necessary infrastructure for waste collection, treatment and disposal. The waste streams taken up in this Regional Outlook include municipal solid waste, industrial and commercial wastes, construction and demolition wastes, and hazardous wastes including electrical and electronic wastes (e-waste), medical wastes and other waste streams, dependent on available data.

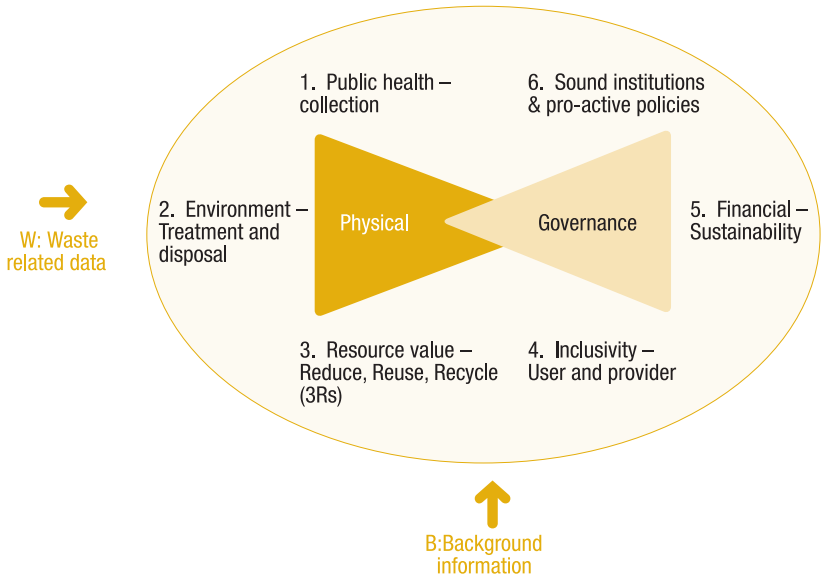
This Regional Outlook examines regional country waste management in the context of the supply chain, emissions to the environment and the socio-economic and environmental impacts of activities within the waste sector across collection, treatment, disposal and return to the supply chain. The Regional Outlook relies on available country inputs, official statistics, studies, research and reports and inputs from the stakeholders involved in its production.

All the countries in this region are affected directly or indirectly by the impacts of past or ongoing regional conflicts and differences that extend beyond the boundaries of West Asia. This theme is developed in the section entitled, “Managing waste in conflict situations: Rebuilding from the ashes” in chapter 3.

An analytical framework for the Regional Outlook

The UNEP GEO6 West Asia Assessment (UNEP 2016) was a driver, pressure, state, impact and response (DPSIR) assessment of the governance, capacity and capability of waste management systems in the region and was aimed at regional decision makers. DPSIR was developed by the European Environment Agency from a pressure state response model, developed by the OECD in 1994, is a flexible framework useful for informing and supporting West Asian country decision makers. The waste aspects of the GEO6 publication have been used as a basis to support the development and environmental themes, in the Regional Outlook, and elements of the DPSIR analysis have been used to make assessments within the Regional Outlook.

Figure 2: The integrated sustainable waste management (ISWM) framework used in the Regional Outlook



Source: Global Waste Management Outlook (GWMO), UNEP/ISWA 2015, Figure 2.3

The Regional Outlook uses a political, environmental, socio-economic and technology (PEST) assessment. The concepts, tools, models and systems necessary for implementation are summarized in Figure 2. In this approach, human health, environmental protection and resource management are linked to institutional governance and may require changes to regulations, funding or wider stakeholder support.

The analysis presented in the Regional Outlook considers actions that are necessary to achieve the Sustainable Development Goal targets in 2020 and 2030. These will be underpinned by sound procurement practices and increased confidence. The success of these actions will be assured through the introduction of sufficient waste treatment capacity employing best practices and best available technologies. However, the outcomes of this work are limited by uncertainties related to the current and future regional political environment, socio-economic development, data reliability and data gaps.

The Regional Outlook's rationale develops vital themes and issues that bring together key aspects and impacts of country waste management activities across the region. The Outlook reviews the existing situation and trends and considers the future needs and actions that will be necessary in order for the region to initiate or develop an effective sustainable waste management response.

Regional Waste Management Outlook development process

The Regional Outlook has been developed through a multi-stakeholder process that involves UN Environment Programme West Asia Office, IETC, ISWA and CEDARE. A small editorial team comprising a lead author and two co-authors supported by a project management team at CEDARE was established to work on the main content. The Outlook also incorporates contributions from regional country representatives and surveys carried out by UN Environment Programme.

The Regional Outlook has been subject to consultations at different stages of its development, including:

- an initial consultation meeting held in Cairo in November 2017 to launch the development process in a way that would ensure the Outlook would be designed to meet the expectations of various stakeholder groups and
- a further meeting in June 2018 that brought together experts from national and local governments, intergovernmental organizations, the private sector, academia and public interest groups.

The contributions and feedback received through this process were instrumental in the refinement and presentation of this Regional Outlook.

Stakeholders

UN Environment Programme supports all West Asia countries. Key stakeholders and organizations provide direct or indirect association, support and guidance on waste management to the 12 West Asian countries. The Regional Outlook aims to be relevant to all countries in the West Asia region, regardless of their current state of development in terms of waste and resource management, cultural differences or the degree to which they are affected by conflict. It is targeted at a relatively high but non-technical level for a wide range of professionals and decision makers in central and local governments as well as other groups of stakeholders, including non-governmental organizations, civil society, businesses, the manufacturing sector, the waste industry, financial institutions and academia.

Historical controlled dumpsite in desert (Source: Author)

Country-level stakeholders include:

- national governments and municipal authorities,
- environment agencies and entities responsible for managing and monitoring waste of all types,
- development and planning authorities,
- all businesses that provide and support waste management services,
- all businesses, organizations and communities that generate waste,
- all businesses that support waste management services including technology providers, developers, construction companies and businesses utilizing waste as a resource or providing access to recycling markets locally, nationally or internationally,
- financial investors, equity and debt capital providers and
- donor countries supporting the development of waste management infrastructure and facilities in developing countries.

Guide to the Waste Management Outlook for West Asia

This Regional Outlook is organized into eight further chapters and an Appendix with detailed data obtained from the 12 West Asian countries.

Chapter 1: Introduction

Chapter 2: Status of Waste Management in the Region

Covering waste generation, waste management practices and climate change issues

Chapter 3: Special Regional Features

Providing insights into the region's cultural activities and heritage

Chapter 4: Waste Governance

Focusing in depth on regulatory and policy instruments and institutional arrangements

Chapter 5: Technologies, Waste Systems and Operations

Development of smart waste systems and added-value technology interventions

Chapter 6: Business and Economic Opportunities in Waste

Understanding costs and benefits, developing partnership and financial models and addressing affordability

Chapter 7: Sustainable Development Goals

Addressing barriers to attaining the Sustainable Development Goals and overviewing what needs to be done

Chapter 8: The Way Forward

Moving forward holistically, the tools to make waste management happen, recommendations

Appendix 1

Country data tables

There are many cross-cutting themes that extend beyond the limits of each chapter. Their key elements are presented through case studies which can be found throughout the Outlook.

Packaging waste around perimeter of fish market (Source: Author)

Chapter 1 References

Aljaradin, M., K.M. Persson, E. Sood (2015). The Role of Informal Sector in Waste Management, A Case Study; Tafila-Jordan. *Resources and Environment*, 5(1): 9-14 DOI: 10.5923/j.re.20150501.02

Baalbaki, R., R. El Hage, J. Nassar, J. Gerard, N.B. Saliba, R. Zaarour, M. Abboud, W. Farah, L. Khalaf-Kairouz, A.L. Shihadeh & N.A. Saliba (2016). Exposure to atmospheric PMs, PAHs, PCDD/Fs and metals near an open air waste burning site in Beirut. *Lebanese Science Journal*, Vol. 17, No. 2 (15 February). Available at https://www.researchgate.net/publication/295398767_Exposure_to_Atmospheric_PMs_PAHs_PCDDFs_and_Metals_near_an_Open_Air_Waste_Burning_Site_in_Beirut

Lansink, A. (2017). Challenging Changes, Connecting Waste Hierarchy and Circular Economy. LEA Nijmegen, the Netherlands. ISBN/EAN 978-90-821783-5-7 NUR 971, 398.

United Nations Environment Programme [UNEP] (2015). *Global Waste Management Outlook*. Available at http://wedocs.unep.org//handle/20.500.11822/9672

United Nations Environment Programme [UNEP] (2016). *GEO-6 Regional Assessment for West Asia*. Nairobi, Kenya. ISBN: 978-92-807-3548-2, 92–99. Available at http://www.unep-wcmc.org/news/geo-6-regional-assessments-launched

Status of Waste Management in the Region

Key messages

West Asia's waste management data is characterized by gaps and inconsistencies. Regionally, an estimated 71.1 million tons of construction and demolition waste was generated in 2016, alongside an estimated 60.4 million tons of municipal solid waste, of which 13.7 million tons went to uncontrolled dumpsites and 10.1 million tons were not collected at all. About 25.8 million tons went to controlled dumpsites and sanitary landfills.

Outlook

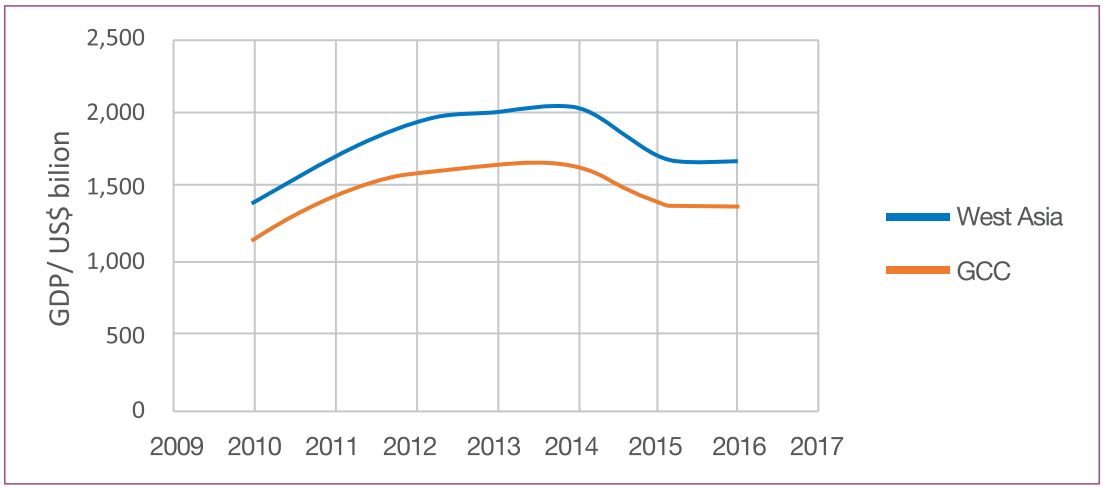
Chapter 2 presents a range of key data trends and indicators that illustrate the status of different countries' waste generation and management in the region. These are compared with international indicators to determine the status of waste management activities, waste generation rates and characterization in the region for all waste types. Key resource recovery activities, quantities generated and markets for recyclables are identified and estimated disposal emissions are presented.

Key drivers and pressures

Understanding the waste streams, quantities and the composition of waste produced by each country is crucial in developing sustainable solutions that incorporate integrated waste management. Waste streams, their quantity and composition are driven by key drivers and pressures. These are related to human activities as waste producers that put stress on land and resource use, which impact on:

- economic development,
- population and
- urbanization.

Figure 3: GDP trends in West Asian countries, 2010 to 2016 [5]



Source: Data from World Bank, 2017a

Economic development is measured as a change in gross domestic product (GDP) or gross national income (GNI). GNI is the sum of a nation's GDP plus net income received from overseas.[6] Regionally, in 2015 GDP fell back to 2011 levels, as shown in Figure 3, after an initial increase (2010–2014) brought about by higher oil prices. Regional GDP was also affected by recessions, austerity measures that affected capital, construction and oil markets, and also trading volumes with Western governments after 2008.

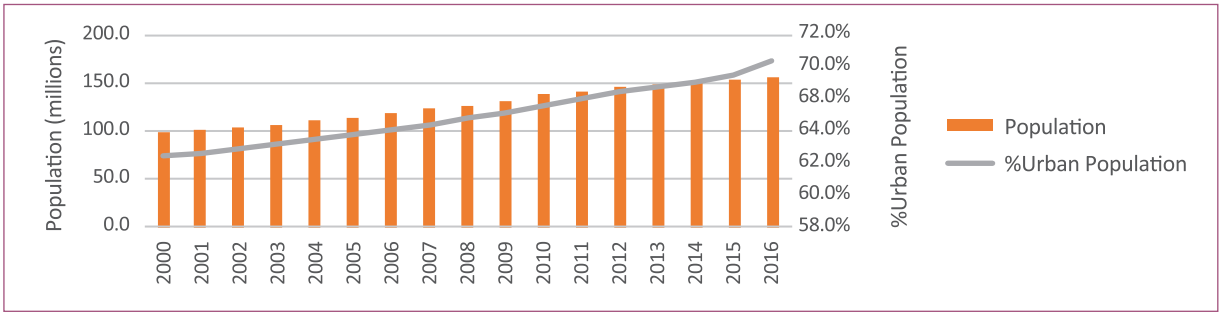
GNI fell by 15.4% and GDP sank by 16.3% for the oil producers of Iraq and the GCC countries between 2014 and 2015. Over the same period, the GNI for Lebanon, Jordan, Palestine and Yemen dropped by 0.8% and GDP decreased by 1.8%.

The total amount of waste in the West Asia region cannot be accurately determined due to data gaps and the wider impacts of past and ongoing regional conflicts that affect seven of the 12 countries (see Chapter 3: Special Regional Features). The population in the West Asia region has increased from 99 million in 2000 to 155 million in 2016, with the GCC countries increasing from 29 to 54 million.

[5] There is no data for Syria for this period.

[6] See http://www.investopedia.com/terms/g/gross-national-income-gni.asp

Figure 4: West Asian population and urbanization trends, 2000 to 2016



Source: Data from World Bank, 2017b

From a waste perspective, the volume of waste is expected to grow hand in hand with increases in population and urbanization levels (see Figure 4), as waste generation rates in urban areas are typically higher than in rural areas. Across the whole region, urbanization increased from 63% in 2000 to 70% in 2016.

Waste-related data and indicators

The West Asia region is a mixture of lower-middle income (Syria, Yemen, Jordan, Palestine), middle income (Iraq, Lebanon), and high-income countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE) that are all defined as developing countries by the World Bank (2018). The key data indicators used in this Regional Outlook generally relate key waste stream parameters of collection, treatment and disposal to time scales, demographic or financial data. Increased collection and segregation of waste will have the greatest positive impact on protecting public health, which, together with treatment and disposal indicators, will reflect the degree to which the UN's Sustainable Development Goals are being met. This Regional Outlook endeavors to present the first assessment for the likely achievement of the Sustainable Development Goals 2020 and 2030 targets by the 12 West Asian countries.

Urban waste depot in Beirut (Source: Author)

The key benchmark, indicator and Sustainable Development Goal categories used in this Regional Outlook are shown below and listed for each country in Appendix I.[7]

[7] Adapted from the Global Waste Management Outlook (UNEP/ISWA 2015), 36-37.

Country									Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.									
Urban population	Nos.									
Refugee population	Nos.									
GNI	US$ billion									
GDP	US$ billion									
Climate	Dry Tropical									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW									
MSW Moisture content (Estimated)	% of MSW									
MSW Inert content	% of MSW									
Informal Sector Collection	% of MSW									
Degradable Organic Carbon (DOC)	% of MSW									
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (Household)	tons/year									
Waste Generation Rate (Household)	ton/inh/year									
MSW Generation (All)	tons/year									
Waste Generation Rate (MSW)	ton/inh/year									
Waste Collection Coverage*	% of total MSW arisings									
Commercial waste	tons/year									
Industrial waste generated	tons/year									
Agricultural waste generated	tons/year									
CDW Arisings	tons/year									
CDW generation rate	tons/year									
E-waste (Household estimates)	tons/year									
E-waste Household Generation	Kg/inh/year									
E-waste (Household MSW)	% of MSW									
Other Indicators										
Hazardous Waste	tons/year									
Medical waste	tons/year									
	Kg/inh/year									
MSW treatment	% of MSW									
Sanitary Dumpsites	% of MSW									
Disposal	% of MSW									
Dumpsite Controlled	% of MSW									
Uncontrolled dumpsites	% of MSW									

Financial	Units	2016
	Year	
Country	GNI/Capita	
Waste Management Budget	US$/inh	
Affordability upper limit (1%)	US$/inh	
Affordability lower limit (0.6%)	US$/inh	

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source
IWM development options costs	US$/inh				

Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)			2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)			2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)			2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)			2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)			2030
SDG 13, Take urgent action to combat climate change and its impacts			No target date

Key *WasteAware* solid waste management benchmark indicator categories have been selected as the most useful for the West Asian countries. Country Sustainable Development Goal targets are indicated by the use of a traffic light assessment.[8]

Overview of the countries waste generation and treatment in the region

The summary of country waste generation and treatment that appears below covers construction and demolition wastes, commercial, agricultural, industrial, and hazardous, e-waste and medical wastes. Municipal waste is covered in a later section.

Construction and demolition waste

Construction and demolition waste is generated from the construction, maintenance or demolition of buildings and infrastructure such as roads and bridges. Construction and demolition waste consists of concrete, masonry, and road surfacing such as asphalt and may include wood, metal, glass, plasterboard and plastics. There are also hazardous substances in demolition waste including treated wood, lead paint and asbestos, so it is important that construction and demolition waste be segregated at source (UNEP/ISWA 2015). In 2016, the annual total amount of construction and demolition waste generated by West Asian countries (excluding Syria, for which no data is available) is likely to be more than 71 million tons, with about 65 million tons generated in the GCC countries.

Table 2: Country annual construction and demolition waste (tons), 2005 to 2016

Country	2010	2011	2012	2013	2014	2015	2016
Bahrain	528,713	534,474	476,163	518,919			708,630
Iraq	6,963,470	4,993,278	4,581,897	4,409,304	3,658,861	2,517,989	4,753,766
Jordan			2,600,000				
Kuwait	6,570,949	8,541,015	7,704,969	8,862,474	10,979,987	11,185,000	11,968,000
Lebanon			68,023	73,000			
Oman			883,714				
Palestine	910				208,996		
Qatar	4,276,414	7,056,350	9,354,487	9,706,885	9,569,784	9,203,462	
Saudi Arabia			18,895,430				20,650,231
Syria	No data available						
UAE			20,471,042				
Yemen	299,231	317,454	336,786	337,297	379,056	402,141	426,632

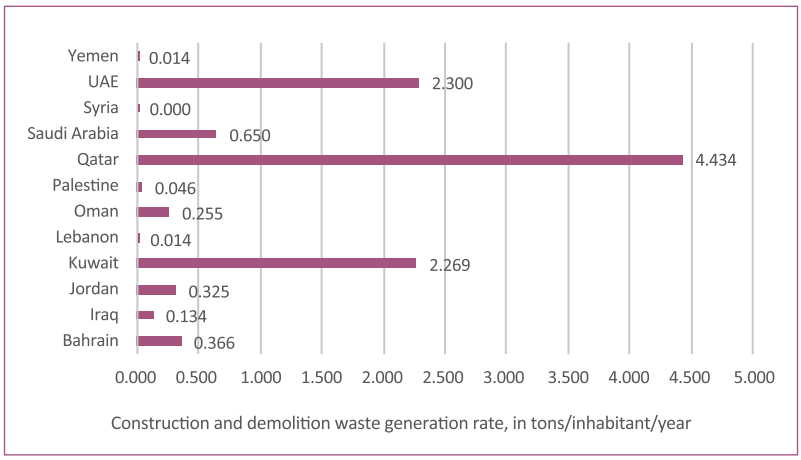
Source: Data appearing in Appendix 1

There has been some very limited reporting of construction and demolition waste in the GIZ/SWEEP-Net country studies of Lebanon (2014b), Jordan (2014a), Palestine (2014c – only small quantities recorded) and Syria (2010a – no data provided). Wide variations in estimates can exist with, for example, 50 million tons being reported in Saudi Arabia for 2014 (Ricardo 2015), in contrast to more recent estimates indicating only a little over 20.65 million tons being disposed in 2016 (Ramboll 2017). The State of Palestine Environmental Quality Authority (SPEQA) reports that the construction and demolition waste generated in the Gaza Strip after the 2014 war amounted to 2.5 million tons, including 20,000 tons of explosives (equivalent to 10 kg per inhabitant).

[8] See Global Waste Management Outlook (UNEP/ISWA 2015), Table 2.3, 36; Wilson et al. 2015

It is understood that over 20 million tons (2.3 tons per inhabitant per year) of construction and demolition waste were produced in the seven Emirates of the UAE in 2012. In Iraq the volume has varied because of the recent conflict, but the country is estimated to have generated about 4.6 million tons (0.134 tons per inhabitant per year) in 2012 (see Figure 5). In comparison, the UK construction and demolition waste benchmark in 2012 was 0.80 tons per inhabitant per year. The Bahrain construction and demolition waste generation rate increased significantly to 0.4 tons per inhabitant per year,[9] recorded in 2016 because of recent rapid development.

Figure 5: Construction and demolition waste generation rates in 2012



Source: Data appearing in Appendix 1. No data available for Syria.

Commercial waste

Across West Asia, most commercial waste, sometimes known as trade waste, is collected as municipal solid waste. However, in Bahrain, Saudi Arabia, the UAE and Kuwait, commercial waste is collected by private companies from offices, hotels, retail and trading businesses. Commercial waste can include packaging, food and product waste. Hazardous waste may arise, for example, from product wastes that are used for cleaning or from electrical and electronic equipment. Often commercial retail and trade wastes are collected together with municipal solid waste as seen in Photograph 1, which shows a yellow municipal waste skip in the streets of Riyadh, Saudi Arabia.

There are also private sector companies in Riyadh collecting commercial waste disposed of in yellow and blue skips, as shown in Photograph 2. These commercial skips are placed close to hotels or commercial apartment blocks. Commercial waste collected in Saudi Arabia in 2016 was estimated at 33.36% of the municipal waste stream, with the private sector collecting an additional quantity amounting to about 30% of the total municipal solid waste collected, which was taken to disposal sites run by the five principal municipalities of Damman, Jeddah, Riyadh, Mecca and Medina (Ramboll 2017).

Photograph 1

Municipal waste skip in the street, close to retail premises in Riyadh, February 2017 (Photo by Author)

[9] See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/683051/UK_Statisticson_Waste_statistical_notice_Feb_2018_FINAL.pdf and https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/timeseries/ukpop/pop

Waste scavengers often take advantage of these areas where businesses use the municipal collection skips, since they are often a source of good quality recyclables, including packaging, cardboard, plastic and metal containers.

In Bahrain in 2016, the 329,629 tons of commercial waste generated were collected by private companies. These companies charge a nominal rate per vehicle, with an estimated cost range of about US$2 to over $5 per ton, depending on the size of the vehicle used and the density of the waste (Sabbagh et al. 2012). In Kuwait, commercial waste is recorded by the Central Statistical Bureau and 341,812 tons were generated in 2014, while in Qatar about 1,474,600 tons were generated in the same year (Qatar Development Bank 2015). In the UAE, commercial waste collected from industrial parks in the Emirate of Abu Dhabi can arise in the same quantity as the municipal solid waste collected (Dumble et al. 2011).

Photograph 2

Commercial waste skip placed in a street in Riyadh, February 2017 (Photo by Author)

Agricultural waste

West Asia engages in a variety of agricultural activities including crop, fruit and animal farming. Some wastes from landscaping and lawn maintenance activities may also be included. Hazardous wastes including those from residues and containers of chemicals or herbicides and pesticides require careful segregation and containment before collection for appropriate treatment and disposal.

In West Asia, agricultural waste is often collected separately. In the Emirate of Abu Dhabi, green waste is taken by farmers to a collection point, where it is transported to composting sites by the waste management entity the Center of Waste Management —Tadweer. Agricultural waste is about 6% of the total non-hazardous waste generated in the Emirate of Abu Dhabi. There is little information or data available on this activity across the region, with annual records from Bahrain ranging from about 117,600 to roughly 173,100 tons in the period 2008 to 2016, while Kuwait's figures more than doubled in the period 2008 to 2014, from 132,276 to 265,725 tons, and only single-year data from GIZ/SWEEP-Net reports for Jordan (2014a) Lebanon (2014b) and Palestine (2014c).

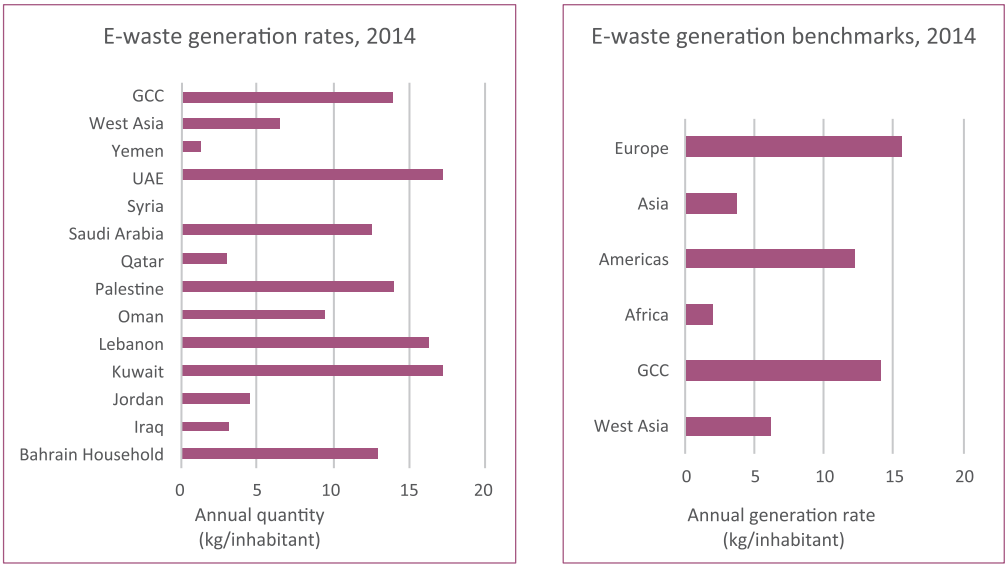
There is very little information on livestock wastes, which tend to be disposed at municipal waste sites or left in collection areas. In Bahrain, figures for dead animal waste range dramatically, from about 5,972 to 16,571 tons annually. The waste-to-energy plant at Mesiaeed in Qatar has facilities to process dead animal carcasses. Elsewhere in West Asia there may be small incinerators available to treat animal carcasses, though it is more likely that these are buried, burned or left to rot.

Estimates by the authors based on available data suggest annual agricultural generation rates of 0.04 tons per inhabitant in Saudi Arabia, 0.12 tons per inhabitant in Bahrain and Palestine, and 0.60 tons per inhabitant in Lebanon and Jordan. These activities may add a small percentage (3% in the Emirate of Abu Dhabi) to the composting totals that are sometimes included within the municipal solid waste stream.

E-waste

The criteria used in the study by Balde et al. (2015, 16-17) to estimate country household e-waste generation per capita is based on the sales of 53 common products and the average weights and lifetimes of e-products. These have been used by Alghazo & Ouda (2016) to estimate e-waste in GCC countries. Using this criterion, e-waste generated per inhabitant in West Asian countries has been calculated and the results are shown in Figure 6. E-waste that arises from industrial, commercial and construction and demolition waste streams has not been not included in these figures, though in practice there may be some overlap as trade and commercial wastes are often collected as municipal solid waste and bulky waste across the region.

Figure 6: West Asian country e-waste quantity estimates



Source: Data from Balde et al., 2015. No data given for Syria.

E-waste is not generally reported as a separate waste stream within municipal solid waste collections. In West Asian countries where data is available, the reported levels of e-waste found are generally less than 1% of municipal solid waste collected. The UN-reported data (Balde et al. 2015), based on country consumer purchases, indicates that e-waste arises in West Asian countries in the range of 0.7% to 4.0% of municipal solid waste collected, with the higher levels recorded by the GCC countries. This may be due to larger household electrical items such as fridges, cookers or air conditioning units being collected by scavengers and taken to scrap metal traders or collected as bulky waste, which may be left out of the municipal solid waste characterization.

International benchmarks set West Asian annual e-waste generation at about 7 kg per inhabitant, with GCC countries about twice this regional level at 14 kg per inhabitant. In contrast, Africa averages about 2 kg per inhabitant per year and Asia averages roughly 4 kg per inhabitant per year, as shown in Figure 6.

Medical waste

Regionally, the amount of hazardous medical waste generated is recorded in units that vary among reports and studies. This variation has been normalized by relating the quantities of waste to the general population numbers as shown in Table 3.

Table 3: Hazardous healthcare waste generation in West Asia

Country	Annual quantity (tons)	Generation rate (kg/inh/year)	Source
Bahrain	1,079	0.76	Bahrain Ministry of Health, 2017
Iraq	11,075	0.20	Iraq Waste Management Outlook country representative
Jordan	4,732	0.50	GIZ/SWEEP-Net, 2014a
Kuwait	3,546	0.87	Kuwait Central Statistical Bureau, 2017
Lebanon	6,980	1.16	GIZ/SWEEP-Net, 2014b
Oman	4,853	0.86	COWI, 2013, 11
Palestine	3,739	0.82	GIZ/SWEEP-Net, 2014c
Qatar	954	0.37	Abou-Elseoud 2008, 119
Saudi Arabia	49,208	1.55	Abou-Elseoud 2008, 119 & http://www.arabnews.com/news/464255
Syria	4,034	0.22	GIZ/SWEEP-Net, 2010a
UAE	22,017	2.38	UAE Environment Agency—Abu Dhabi, 2013, 4
Yemen	4,576	1.07	Yemen Waste Management Outlook country representative

Source: Compiled by Author

The total hazardous healthcare waste produced in West Asia is provisionally estimated at just short of 152,000 tons, of which roughly 80,600 tons were generated in GCC countries using 2016 population data. There appears to be a wide variation in medical waste generation rates, with the GCC countries averaging 1.62 kg per inhabitant annually (with a range of 0.76 to 2.38) and all West Asian countries averaging 0.98 kg per inhabitant annually (with a range of 0.20 to 2.38).

Industrial waste

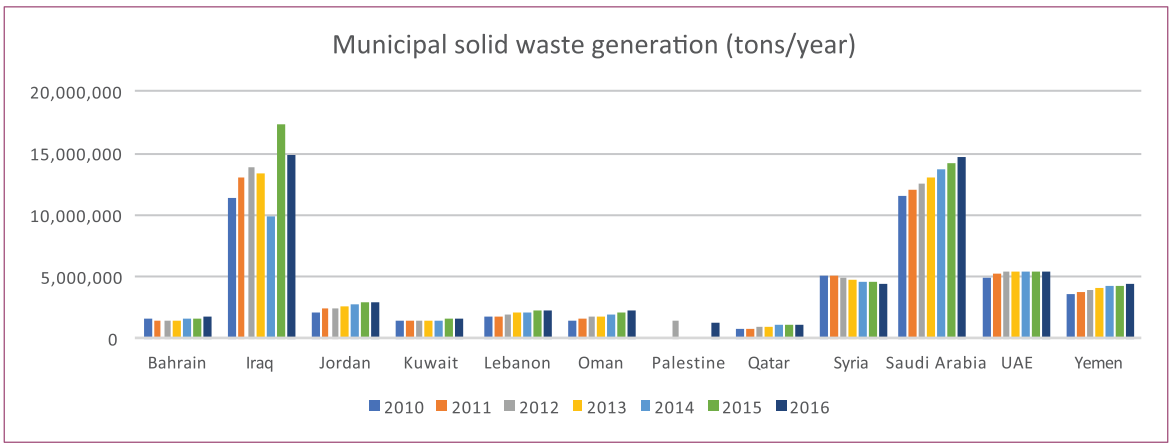
Industrial waste is mainly handled in the oil producing countries by the oil and gas entities, such as ADNOC in Abu Dhabi, KOC in Kuwait, PDO in Oman or Aramco in Saudi Arabia (UNEP 2016). In Abu Dhabi, ADNOC only treats hazardous waste from its own oil & gas facilities. All industrial waste generated from all industries located in zones designated as ICADs, AAICs and KIZAD are treated and managed by facilities under Abu Dhabi's Center of Waste Management—Tadweer. Other industrial wastes, for example drilling waste, wastewater, sludge and waste from steel production and aluminum plants, are likely to be stored on site where they are produced or disposed in dumpsites and municipal disposal sites. In 2016, almost 95,000 tons of industrial waste were generated in Bahrain. This was a dramatic increase from the 34,000 tons in 2005 recorded by the Ministry of Works, Municipalities Affairs and Urban Planning (MOMUA). Taking into account the conflicts going on in Iraq since 2011, the amount of industrial waste generated has varied considerably, from a peak of 14,634 tons in 2012, plummeting to 6,746 tons in 2015 and then rising again to 9,329 tons in 2016 (Iraq Waste Management Outlook country representative). Industrial waste has grown in Oman from 86,000 tons (2012) to 97,860 tons in 2016 (COWI 2013). Palestine had a recorded 131,344 tons of industrial waste (GIZ/SWEEP-Net 2014c) and Lebanon 112,512 tons in 2013 (GIZ/SWEEP-Net 2014b).

Other industrial waste data is mainly based on pre-2010 estimates, with some going back to 1995 (Abu Elseoud 2008, 117-123). There has been no data found on mining wastes in the region and wastewater is outside the scope of this Regional Outlook.

Overview of municipal solid waste generation and treatment

Regional variations in waste quantity and type generally follow trends in changes to GDP, urbanization and population changes. From the year 2000, there is an increase in waste growth (much greater in the GCC countries of West Asia), decreasing in 2008 and 2009, then rising again to 2014 with waste growth rates falling away in the period 2014 to 2016. However, the changes in municipal solid waste generation at the country level over the period 2010 to 2016 is more complex, as shown in Figure 7.

Figure 7: Trends in municipal solid waste generation, 2010 to 2016



Source: Data appearing in Appendix 1

Excluding waste collected by the informal sector and considering all municipal solid waste collected and uncollected, the estimated total municipal solid waste generation for West Asia has grown from roughly 46,289,600 tons in 2010 to approximately 56,604,900 tons in 2016, excluding wastes taken out by scavengers, with the amount of municipal solid waste increasing annually from 2011 to 2015 but then dropping by -2.5% in 2016, mainly because of a substantial drop in Iraqi municipal solid waste as shown in Table 4 and Figure 7.

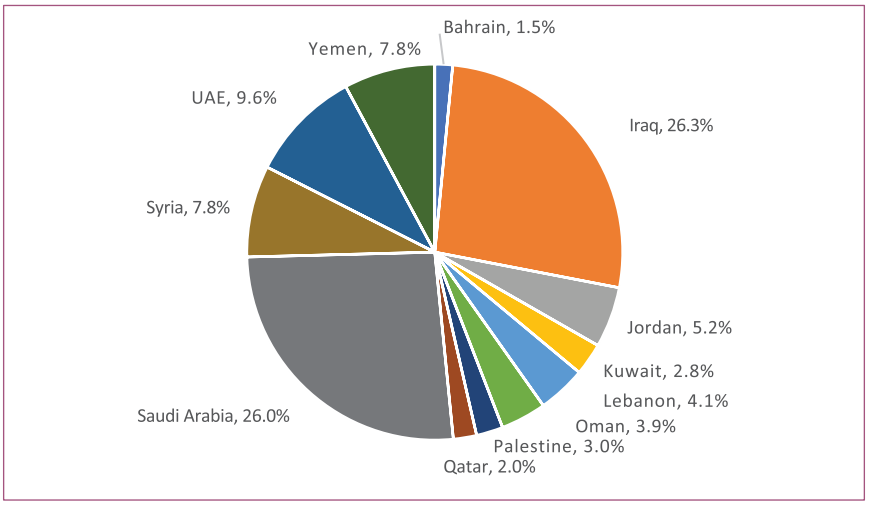
Table 4: Trends in regional municipal solid waste growth

Year	2011	2012	2013	2014	2015	2016
Growth	6.3%	4.2%	1.3%	1.8%	9.8%	-2.5%

Source: Compiled by Author from data in Figure 7

The chart in Figure 8 shows that in 2016, the highest amounts of municipal solid waste were generated by Iraq with Saudi Arabia, followed by the UAE, Yemen and Syria.

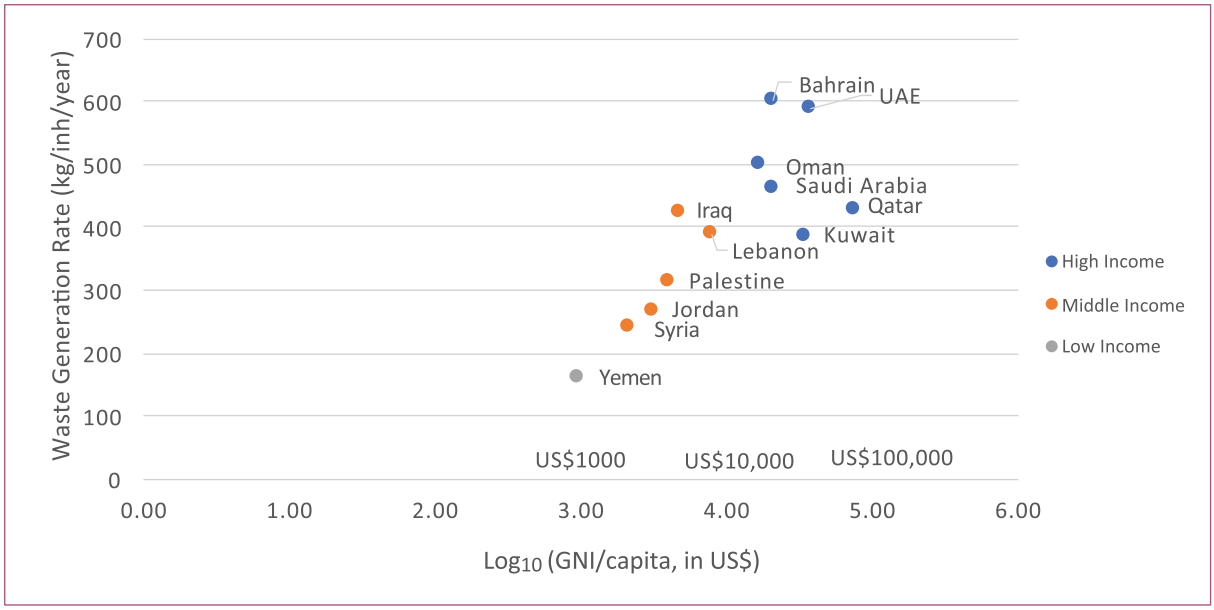
Figure 8: Municipal solid waste, broken down by West Asian country of origin, 2016



Source: Data appearing in Appendix 1

In Figure 9, the waste generation rates of the 12 West Asian countries when compared to national income levels show a loose association to a linear regression (r^2=0.62, n=12 or r^2=0.50, n=12 where the intercept is set at zero), with the same relationship for 82 countries (r^2=0.72, n=82) depicted in Figure 3.3 of the Global Waste Management Outlook (UNEP/ISWA 2015). This is better illustrated with the high, middle or low-income country boundaries occurring in the same income regions on both charts ($1000, $10,000, $100,000), reflecting the association with country income-related global benchmarks.

Figure 9: Waste generation and income level by country



Source: Data appearing in Appendix 1

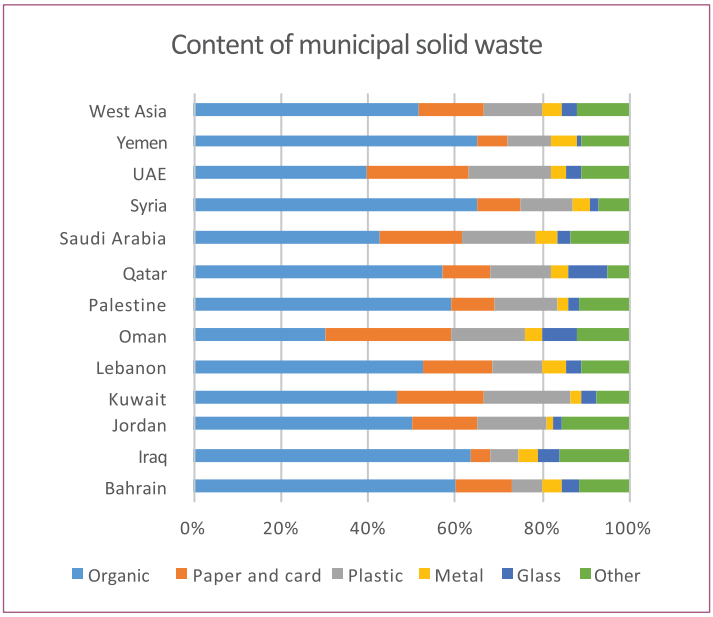
The GCC countries in 2016 generated roughly 45.4% of the total amount of municipal solid waste in West Asia countries, maintaining roughly the same level they did in 2010, when they generated about 45.7%. West Asian waste generation rates that have risen from 337 kg per inhabitant per year in 2010 to 379 per inhabitant per year in 2015, decreasing to 366 per inhabitant per year from 2016.

Waste generation rates in Syria and Yemen—affected by conflict—and in Jordan—affected by refugees—reflect benchmarked averages shown in Figure 9 for low middle-income and low-income countries. Waste generation rates in high-income GCC countries are at the lower end of high-income countries in the Global Waste Management Outlook chart (UNEP/ISWA 2015) and the OECD average (Bhada-Tata & Hoornweg 2012).

Waste composition and characterization

Waste composition is a critical factor, as this determines the suitability of treatment methods or whether pretreatment methods need to be used. The higher organic fraction found in the municipal solid waste of Iraq, Jordan, Lebanon, Palestine, Syria and Yemen shown in Figure 10 indicates a high moisture content. In Lebanon, the moisture content is estimated at 53.0%. This is reported as being up to 60%, which is probably due to the high rate of waste scavenging in Beirut (20%), which leaves behind residual waste having a higher food content, as well as the use of open street collection containers, which can be affected in the colder seasons by a higher level of rainfall (Lebanon CDR 2015). Bahrain and Yemen have the highest organic levels in the Arabian peninsular, with high organics content and characterized by moisture contents of 47.4% and 48.4% (see Figure 11). The other GCC countries have municipal solid waste characterizations with lower organics waste content and higher levels of plastic, paper and metal.

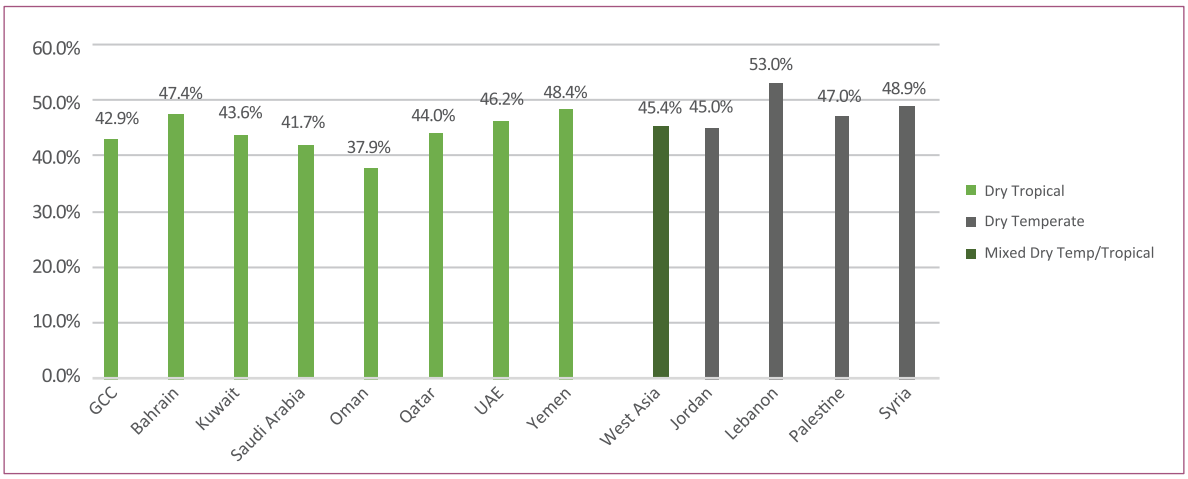
Figure 10: Country municipal solid waste characterization for West Asian countries



Source: Data appearing in Appendix 1

In a global review (Bhada-Tata & Hoornweg 2012, 19) Bahrain, Qatar and the non-GCC countries exhibit characterizations more typical of middle-income countries. However, Kuwait, UAE, Oman and Saudi Arabia reflect a characterization transition toward that of high-income countries with lower organic waste content, ranging from 37.9% (Oman) to around 43.6% (Kuwait).

Figure 11: Moisture content of municipal solid waste in West Asia countries

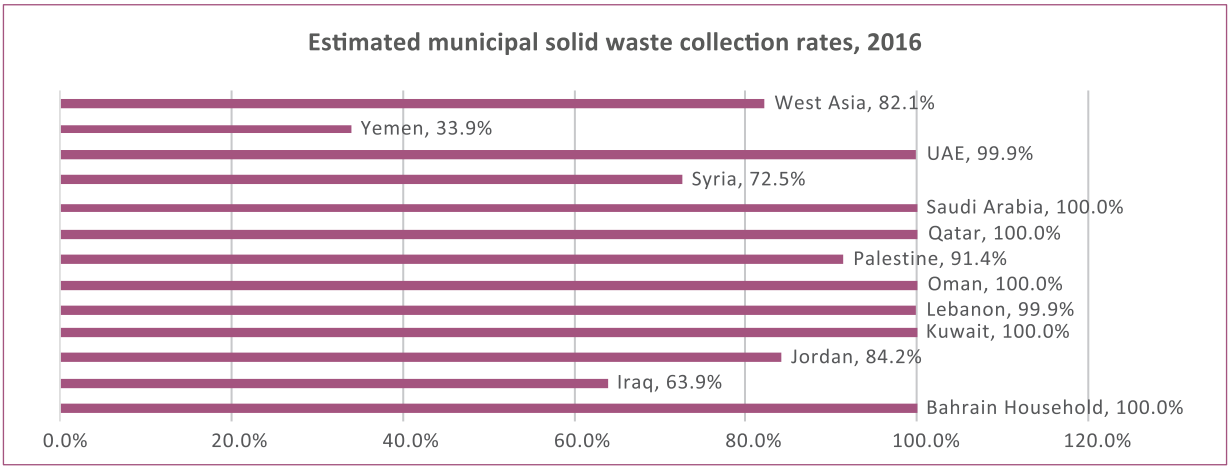


Source: Data compiled and estimated by the authors

Status of municipal solid waste management: Protection of public health and the environment

Municipal solid waste is collected primarily as a service to prevent nuisances such as odours and pests and to avoid the spread of contagious diseases from rotting waste, as well as harmful emissions and contaminants.

Figure 12: Municipal solid waste collection rates in West Asia, 2016

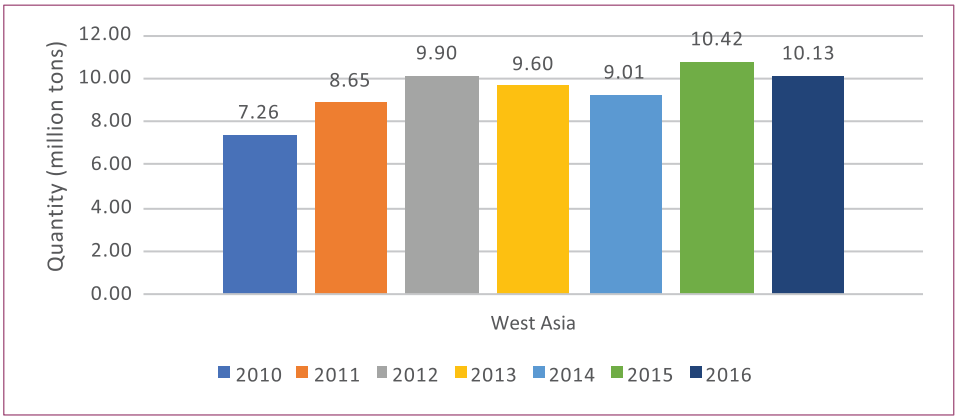


Source: Data appearing in Appendix 1

It is typically assumed that there is 100% collection coverage in the GCC countries. However, it is more likely that remote or less accessible towns and villages may (as happens in Lebanon) arrange a general collection that is dumped locally, or the waste is simply burned or dumped by the residents. So, the actual municipal solid waste collection coverage for GCC countries may in fact range between 97% and 100%. Across the entire region, the percentage of municipal solid waste that is collected for treatment and disposal has decreased from 84.3% in 2010 to 82.1% in 2016, reflecting a period of conflict in the region. The most significant change has been in the countries directly affected by conflict, namely Iraq, Syria and Yemen, as seen in Figure 12.

The amount of uncollected waste has varied every year in the period 2010 to 2016 and has risen from 7.26 million tons in 2010 to 10.13 million tons in 2016. It should be noted that beginning with 2011, the dataset in Figure 13 includes only estimates of Syrian data due to the increasing impact of conflict in the country. This figure was also compiled with various uncertainties and omissions in data from Iraq and Yemen.

Figure 13: Estimated uncollected waste in West Asia, 2010 to 2016



Source: Data estimated by author from data appearing and sourced in Appendix 1

Informal sector

It is noteworthy that the informal sector is very active in all West Asian countries. Some of this activity is allowed or tolerated by the municipal authorities. There are often large-scale local users of scavenged recyclables, such as paper or card sector industries, that fund these collection activities and there is very little data available on such activities. In Saudi Arabia, where scavenger activity has been observed in the early hours of the morning, and in the UAE, about 10% of municipal solid waste is scavenged before official street collections are made (Dornier 2008). The estimates for scavenged waste in Lebanon range from 20% in Beirut to 2% in the governorates of North Lebanon, South Lebanon and Bekaa (Lebanon CDR 2015).

Street dumping and fly tipping[10] in Lebanon

Before the dumpsite surveys in Lebanon were carried out by the Ministry of the Environment and the United Nations Development Programme (2011 & 2017), few dumpsites had been closed, remediated or rehabilitated. Local environments were facing increased pressures from uncontrolled dumping that affect the quality of the air, watersheds, and coastal zones, which in turn impact on environmental health, tourism, recreational areas, amenities, marine environments and fish catches (World Bank 2011, 35-36). Street dumping after the 2015 waste crisis in Lebanon was reported in the media, characterized by public demonstrations with graphic scenes of waste burning and waste piled up in the streets (Azzi 2017, 13).

CASE STUDY – Fly tipping in the Emirate of Abu Dhabi in 2010, prior to the introduction of waste tracking systems

In 2007 in the Emirate of Abu Dhabi, UAE, the Environment Agency—Abu Dhabi (EAD) carried out an aerial survey of fly-tipped waste across the Emirate, photographing and identifying the location of over 18,460 illegal sites. An inspection survey was carried out over three months to provide estimates of wastes that had been illegally tipped.

Table 5: Estimates of fly-tipped waste in an area of Abu Dhabi covered by two collection contracts

Type of waste	No. of locations	% of locations	Total quantity/m³	% by volume
Farm waste	23	4.0%	6,710	9.7%
Bulky waste	18	3.2%	6,400	9.3%
Construction and demolition waste	258	45.3%	48,631	70.6%
Green waste	88	15.5%	6,038	8.8%
Sand	104	18.3%	1,063	1.5%
Tyres	78	13.7%	85	0.1%

Source: Dumble, 2011, based on data from Golders Associates

Analysis of an inspection survey conducted in 2010 produced estimates of fly-tipped waste by type and volume as shown in Table 5 (Dumble 2011). Over a three-month period, just under 10,000 incidents were recorded.

[10] "Fly tipping" is disposing of waste illegally, rather than at a location authorized to receive it.

Table 6: Abu Dhabi 2010: Analysis of fly-tipped waste incidents by volume

Volume range of illegal dumping incidents	Estimated total volume (m^3)	% by volume	No. of illegal sites	% of illegal sites
Up to 10 m^3	346	0.6%	65	23.9%
11- 50 m^3	3,005	4.9%	83	30.5%
51-100 m^3	3,175	5.2%	36	13.2%
101-200 m^3	11,692	19.2%	44	16.2%
201-500 m^3	7,830	12.8%	22	8.1%
501-1000 m^3	11,700	19.2%	15	5.5%
1001-5000 m^3	23,200	38.1%	7	2.6%

Source: Dumble, 2011, based on data from Golders Associates survey, 2010

An issue identified from this study relates to the number of construction sites where waste was left for the authority to clear up after construction was completed. Table 6 shows collated data for inspectors using data loggers to photograph and locate (using GIS coordinates) illegal deposits. The analysis shows that the most substantial volumes were being dumped at a small number of sites. This indicates common usage of these illegal dumping sites by the waste transporters (Dumble 2011).

Marine waste

West Asia has a large coastline around the six GCC countries and Yemen, with Syria and Lebanon on the Mediterranean. About 40% to 45% of the GDP of most GCC countries is dependent on plastic-related activities (GPCA 2014). The GCC countries have an annual polymer production capacity of 27.1 million tons, of which 89% are commodity polymers such as high and low-density polyethylene, with thermoplastics produced there representing 9% of the global market. According to the Gulf Petrochemicals and Chemicals Association (2016) about 9% of municipal solid waste is recycled across all GCC countries,[11] though it is not clear how much of this is recycled plastic waste.

On the Mediterranean coast there are land-based dumps on the coast at Saida and Beirut in Lebanon and the world media have recently reported the blighting of the beaches by litter.[12] Other coastal waste inputs occur in Yemen and along the GCC countries bordering the Gulf. There is a need to quantify the marine litter that adversely affects the coastal areas of the island of Bahrain, which requires support to implement measures to prevent illegal dumping and control transboundary movements of plastic waste.[13] About 1% to 4% of all plastic waste ends up in the marine environment, primarily from fishing, shipping and coastal sources, amounting globally to an estimated 8 million tons every year (Jambeck et al. 2015).

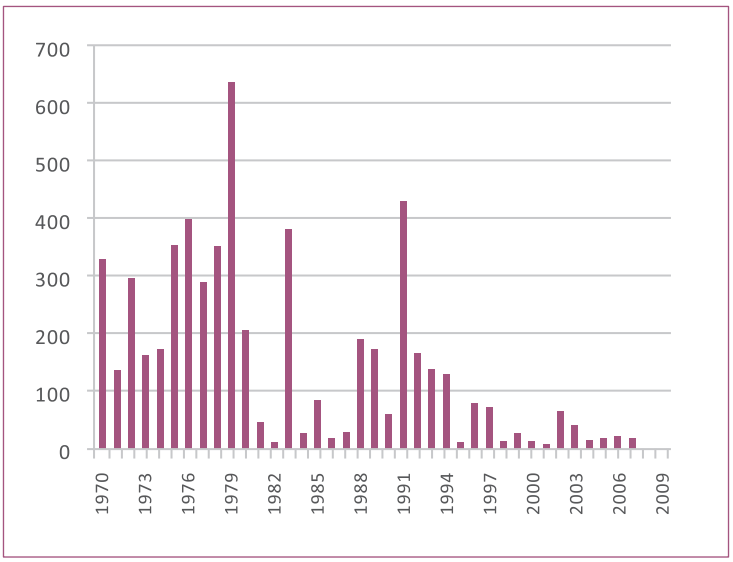
The Marpol Convention of 1978 covers discharges from ships into the marine environment and requires ports to provide facilities for the collection and disposal of wastes. The convention does not cover land-based waste entering the marine environment. This includes litter, eroded coastal disposal sites and illegally deposited wastes that contaminate waterways, estuaries and coastal environments. The West Asian region has a large number of oil and gas producers that export using overland pipelines and marine transport. As shown in Figure 14, the Convention has resulted in dramatic decreases in oil contamination from sea tankers and marine oil spills. It has also reduced ballast discharges from sea tankers.

[11] This may include waste collected by the informal sector.

[12] See http://www.bbc.co.uk/news/world-middle-east-42788829

[13] The source is the Bahrain Waste Management Outlook country representative.

Figure 14: Global quantity of oil (thousand tons) spilled from tankers, 1970–2009



Source: International Tanker Owners Pollution Federation, 2010

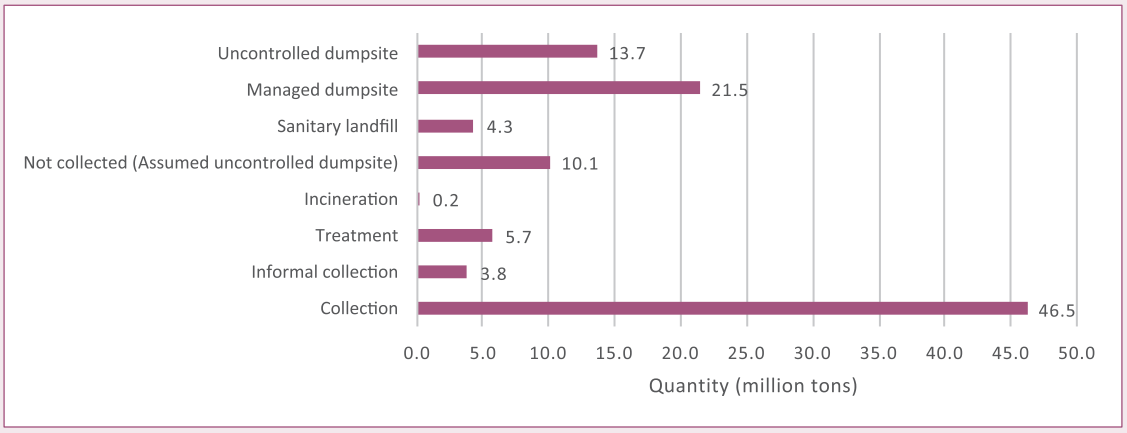
Considering international actions to ban specific plastic products,[14] it is important that regional oil producer governments demonstrate to the world that plastics can be managed, used and handled, recycled and disposed in sound ways that do not lead for example to the pollution of marine environments.

Waste by destination

To understand how the circular economy will apply in West Asia, it is important to know where the waste goes after it is collected and understand why certain waste treatment methods are better suited to the types of municipal solid waste arising in the West Asian region. There is insufficient current data (UNDP 2011) to assess waste by destination on a country basis, so an estimate is shown in the following case study, based on data and also the knowledge of the authors.

CASE STUDY – Municipal solid waste by destination in West Asia

Figure 15: West Asia waste by destination, in the 2016 Waste Management Outlook assessment



Source: Data estimated by author from data appearing in Appendix 1

[14] See https://www.theguardian.com/business/2018/feb/20/plastic-bans-worldwide-will-dent-oil-demand-growth-says-bp

An estimated 23.8 million tons of a total of 60.4 million tons of municipal solid waste, including waste collected by the informal sector, end up in unlined dumpsites that are uncontrolled. There is a small amount incinerated (in Qatar) with an estimated 5.7 million tons going to treatment operations such as sorting and composting plants with a high process reject rate (up to 80%). The primary source-segregated waste of about 3.8 million tons comes from the informal sector, with a further estimated 0.5 million tons of sorted recyclables and 1.9 million tons of compost from mainly agricultural sources. There is a need to upgrade the current treatment capacity and also increase the capacity to deal with waste not currently being collected in countries affected by conflict. The current treatment capacity deficiency is about 46.4 million tons, which includes uncollected municipal solid waste.

Unsound waste management practices that affect communities are shown in case studies in Lebanon and Palestine.

CASE STUDY – Health impacts of open burning of waste in Lebanon

In urban areas in Beirut, Lebanon, open-air waste burning became widespread after the waste crisis of 2015 (Azzi 2017). The study by Baalbaki et al. (2016) looked at the effects of open burning on air quality and public health in October and December 2015. Levels of particulates (PM10, PM2.5), gaseous and particle-bound polycyclic aromatic hydrocarbons, polychlorinated dibenzo-dioxins and furans, and particle-bound metals at nearby housing were measured to determine the cancer risk.

Increased short-term cancer risk

The study indicated that the short-term cancer risk increased by a factor of 20 on days that waste was being burned. These findings were shared with communities affected, alerting them to poor practices in waste management, the need for improved governance and the adoption of best practices.

In Lebanon, of the 459 tons disposed of daily in open dumps, it is estimated[15] that 290 tons were open-burned while 169 tons were deposited into existing dumps. This will increase the open dump leachate seeping into the ground at a rate of 0.25 to 0.35 tons of leachate per ton of waste per year[16] and release air pollutants that cause both nuisances and damage from odours and pollution (MOEL/EU/UNDP 2014).

E-waste processing

CASE STUDY - Health impacts of burning e-waste in Palestine

About 200 to 500 tons per day of e-waste are illegally imported to Idhna in the Heron Governorate of Palestine despite the penalty for the import of hazardous waste being life imprisonment. A GIZ/SWEEP-Net study on Palestine (2014c, 81-82) reported that “Illegal e-waste imports have transformed fertile land into electronic graveyards.” Similar activities occur in Al Kum, Beit Maqdum and Al Yassaria. The burning of e-waste to quickly recover metals is carried out in the open despite health concerns, with many of the 1,000 workers in the Idhna area being under the age of 16. The residual waste is disposed of on land as municipal waste, with recyclables exported to neighbouring countries coordinated or managed by private operators.

In a recent study by Davis & Garb (2018), the authors report a strong spatial association between the cumulative presence of e-waste burn sites and an independently established childhood lymphoma cluster in southwest Hebron.

[15] Calculations based on MOEL/UNDP/ELARD 2011, Annex B, table B2.

[16] Calculations based on Naameh sanitary landfill data.

Dumpsite and perched groundwater (Source: Author)

Up until 2013, there were no regulations relating to electronic and electrical wastes in Bahrain, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, the UAE or Yemen. However, Iraq had regulations in effect (Balde et al. 2015).

In West Asia household e-waste is generally disposed of in municipal street collection containers or put out as bulky waste for collection. The hazardous nature of electrical and electrical waste becomes apparent in the mechanical separation and the chemical (Tsyenova & Bengtsson 2011) or thermal treatment of the e-devices (Perkins et al. 2014) as illustrated in the Palestinian case study above.

Medical waste

Medical waste across the region is generally treated using autoclave and small-scale incineration facilities. There are some gaps in provision but there is no information available from most of the countries concerned regarding treatment capacity. In Bahrain, since April 2002 a private facility, the Bahrain Waste Treatment Company (BWTC), has been treating and incinerating healthcare waste generated in the country through two incinerators that can handle 250 kg of waste per hour. Recently, the King Hamad University Hospital has installed two autoclave units providing sterilization using high-pressure steam treatment, processing 300 kg of medical waste per cycle. Similarly, the Bahrain Defense Force (BDF) has installed an autoclave unit for treating BDF hospital waste.[17]

CASE STUDY - Recyclables and secondary raw material markets

In January 2018 the author interviewed a marketing expert at the central sorting and composting plants in Beirut, Lebanon to establish recycling destinations and products made from recyclables. Table 7 provides a limited but essential overview of the regional and international distribution chains of recyclables and the local and regional markets available to recyclables sourced from waste sorting plants. These markets make use of the recyclables as secondary raw materials.

[17] The source is an interview with the country representative for Bahrain.

Table 7: Illustration of trading of recyclables from sorting and composting plants in Lebanon

Recyclable	Quality	Destination	Notes	Products
Paper, magazines and tissue	Mixed	Turkey; Wadi Chahrour, Lebanon	New opportunity	Paper
Cardboard	Class A, B & C	Turkey; Wadi Chahrour, Lebanon	Syria (now via road access)	Cardboard
PET	Sorted, washed, shredded	Remanufacturing in Lebanon	Influenced by oil prices	Fleeces, mattress covers, boot liners
HDPE	Sorted/ shredded	Turkey	Influenced by oil prices; not influenced by China's recycling ban	Mainly exported
Mixed plastics	Sorted	Turkey	Influenced by oil prices; potential for local remanufacturing enterprises	Mainly exported
*Nylon/LDPE	Clear, coloured	Turkey	Potential for local remanufacturing enterprises	Turkey building new capacity for re-use of nylon
Aluminium, cans, trays and scrap	Bailed, mixed	China; Turkey; Pakistan; Armenia	Smelters	Aluminium
Tin	Cans, scrap	Pakistan	Magnetic recovery; treatment for metal recovery	Tin; iron
Copper	Scrap	Local markets	Local markets	Copper
Brass	Scrap	Local markets	Local markets	Brass
Gold	Jewellery	Local markets	Local markets	Jewellery
Silver	Jewellery	Local markets	Local markets	Jewellery
Electronic equipment	Used products	Local markets	Local markets	Refurbished items
Tyres	Whole, shredded	Tyre plant - S Lebanon	A second tyre plant planned in Bekaa valley	Oil; carbon black; steel
Wood	Tree logs	No current takers	Not currently sold	Logs for heating
Wood	Furniture	Local markets	Local markets	Refurbished items
Wood	Pallets	Local markets	Repair	Pallets
*Note: LDPE appears to be known as nylon by the marketing expert interviewed				

Source: Interview with marketing manager in Lebanon, by Author, 2018

The PET plastic usage for the manufacture of fleeces, mattress covers and boot or shoe liners is an example of a best practice that can be generated between the waste service providers and entrepreneurial businesses in building the circular economy. In addition, there are a number of opportunities for local businesses. This will encourage waste operators to invest in more advanced equipment and increase the efficiency of their sorting processes. Current increases in the price of recyclables and the potential increased market demand for generating recyclables through source segregation and modern sorting practices offer many remanufacturing opportunities, as indicated in Table 7.

There is potential to recover valuable metals such as gold and platinum as waste collection systems receive more and more electronic waste. Secondary (non-ferrous) smelter capacity and gaps in capacity in West Asian countries are shown in Table 8 with the largest smelter capacities found in Bahrain, Oman, Saudi Arabia and the UAE.

Table 8: Secondary smelters in West Asian countries, 2015

	No. of secondary smelter companies found	Annual non-ferrous scrap quantity/ton	% share of known scrap quantity
Bahrain	4	472,000	32.2%
Iraq	0	0	0.0%
Jordan	5	23,000	1.6%
Kuwait	2	6,500	0.4%
Lebanon	1	0	0.0%
Oman	2	78,000	5.3%
Palestine	1	5,000	0.3%
Qatar	0	0	0.0%
Saudi Arabia	9	548,000	37.4%
Syria	5	15,000	1.0%
UAE	3	140,000	9.6%
Yemen	0	0	0.0%
Total	50	1,463,900	100.0%

Source: Compiled by Rudolf P. Pawlek (2015). "Secondary Smelters." https://www.lightmetalage.com/producers.php

Asian countries demand higher quality standards for imported recyclables

The Chinese government, the largest global importer of recyclables, in July 2017 notified the World Trade Organization of its plans to ban the import of recyclables, including types of plastic, unsorted paper, and metals, in accordance with its "Operation Green Fence" program[18] known as "National Sword" which addresses enforcement and the import of contaminated or poor-quality recyclables that cause damage to human health and the environment. This requires a shift in the business models adopted by traders in countries exporting their recyclables in order for them to continue to have access to markets in China and other countries that will still import higher value, quality recyclables.[19] At the time of writing, further actions to ban low-quality plastic imports are being considered by Southeast Asian countries such as Vietnam, Malaysia and Thailand.[20]

CASE STUDY- Development of waste-to-energy capacity in West Asian countries

Developed regions around the globe, such as Western Europe, the United States and Japan use incineration as a principal waste treatment method. It has been estimated that in the last few decades the global capacity of incineration has risen from 160 to 200 million tons per year and is projected to reach up to 240 million tons per year by 2021 (Chin 2011). In West Asian countries, plans for waste-to-energy plants are at the infancy stage. There are several ongoing waste-to-energy projects under development or consideration in West Asian countries including Kuwait, Qatar, Saudi Arabia (Ouda et al. 2016, Nizami et al. 2015), the UAE and Oman (see Table 9).

[18] "Operation Green Fence" is the name of a range of efforts by China, launched in 2013, to strictly enforce already-existing waste quality legislation. These efforts include stringent inspections of incoming scrap materials, often on a container to container basis, and a full-out ban on the importing of certain materials, a program known as "National Sword." See https://www.theguardian.com/sustainable-business/china-green-fence-global-recycling-innovation

[19] See http://www.orra.net/wp-content/uploads/2017/09/China-Recyclables-Ban-Fact-Sheet_ORRA_September-2017.pdf

[20] See https://www.rebnews.com/bans-on-plastic-recycling-imports-put-in-place-in-vietnam-and-thailand-paper-restrictions-too/ and https://www.rebnews.com/bans-on-plastic-recycling-imports-put-in-place-in-vietnam-and-thailand-paper-restrictions-too/

Table 9: Future waste-to-energy (WTE) projects in West Asian countries

Facility	Location	Project investment	Project start date	Estimated completion date	Key stakeholder	Plant capacity	Power generation
Dhofar WTE facility	Oman	About $600-$700 million	April 2015	At feasibility stage	Be'ah	2,100 tons/day	33.3 MW
Kabd WTE project	Kuwait	$1.5 billion	November 2013	Under planning	Partnerships Technical Bureau (PTB)	3,275 tons/day	45 MW
Sajja 80MW WTE project	Sharjah, UAE	$505 million	May 2014	Construction due to start in 2016	Sharjah Environment Company (Be'ah), Chinook Sciences	400,000 tons/ year	20 MW
Dubai municipality 60MW plant	Al Warsan 2, Dubai, UAE	AED 2 billion	June 2016	2020	Dubai municipality	2,000 tons/day	30 MW
Qatar domestic solid waste management center	Near Mesaieed, Qatar	$1.7 billion	Early 2007	June 2012	Keppel Integrated Engineering (KIE), SMEC International	2,300 tons/day	34 MW
TAQA Musaffah 100 MW facility	Near Mussaffah, Abu Dhabi, UAE	$859 million	February 2013	Project cancelled	TAQA, Ramboll	1 million tons/ year	100 MW

Source: International Quality Productivity Center 2016

Waste and climate change

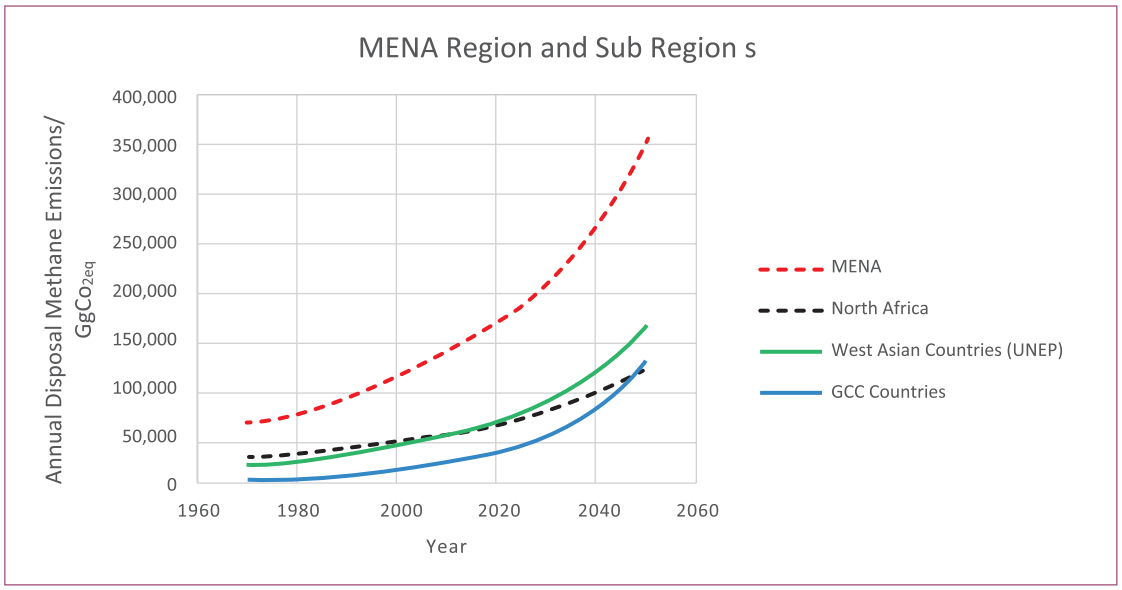
Waste emissions are influenced by the amount of biodegradable carbon that is present in the waste, the quantity of waste, how it is disposed of, the climatic conditions of the region and how the waste degrades. By diverting waste as a raw material back into the supply chain, embodied emissions are saved by reducing the amount of virgin raw material taken from the ground or the marine environment and reducing the required energy or fuel required for supply chain processing, manufacture, transport and distribution of the products, reducing the quantity of waste going to land disposal. Between 15% and 20% of global greenhouse gas emissions could be saved through supply chain waste reduction measures, recycling, energy conversion, landfill mitigation and diversion. A detailed overview of waste and climate is provided in the Global Waste Management Outlook (UNEP/ ISWA 2015, Topic Sheet 1, 12-15).

Country waste emission declarations

Historically, municipal solid waste disposal methane emissions declarations by West Asian countries to the Secretariat of the United Nations Framework Convention on Climate Change have been intermittent (IPCC 2006).[21]

[21] See in particular the section "Greenhouse Gas Inventory Data—Detailed Data by Party, Non Annexed Parties," Category: 6.A - Solid Waste Disposal on Land - Gas: CH4 - Unit: Gg CO2 equivalent

Figure 16: Unmitigated methane emissions from MSW disposal in MENA region and subregions



Source: Dumble, 2017. chart by Author from original modelling data.

Among West Asian countries, Bahrain, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar and the UAE have ratified the Paris Agreement, the climate change accord[22] agreed at the twenty-first session of the Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC), held in Paris in 2015.[23] West Asia is divided into two climate regions—dry temperate, found mostly in the Arab Maghreb region and including Iraq, Jordan, Lebanon, Palestine and Syria, and dry tropical, which includes the six GCC countries and Yemen on the Arabian Peninsula.

Food and packaging waste around vehicle parked at food market in Beirut (Source: Author)

Recent Intended Nationally Determined Contributions (INDCs) and United Nations Framework Convention on Climate Change greenhouse gas national inventory reports for West Asian countries have been inconsistent or deficient in setting out practical ways to achieve targeted emission reductions from waste management activities.[24] For developing countries, such considerations are essential in estimating costs. When implementing integrated waste management systems, these costs will determine the necessary investment funding and impact on the development of the necessary waste treatment options.

There have been recent studies undertaken on municipal solid waste and leachate emissions that cover the GCC, West Asia, and the Middle East and North Africa (MENA) region and subregions. (Dumble et al. 2017; Dumble 2017). Without action, methane disposal emissions for the West Asia region are forecast to exceed 167,000 $GgCO_{2eq}$ by 2050 (see Figure 16).

[22] See http://www.un.org/sustainabledevelopment/blog/2016/04/parisagreementsingatures/

[23] Paris Agreement available at https://unfccc.int/process/the-paris-agreement/what-is-the-paris-agreement

[24] See MOEL/UNDP/GEF 2015 and Secretariat of the United Nations Framework Convention on Climate Change [UNFCCC Secretariat] (2017b)

CASE STUDY – Rehabilitation of dumpsites in Lebanon

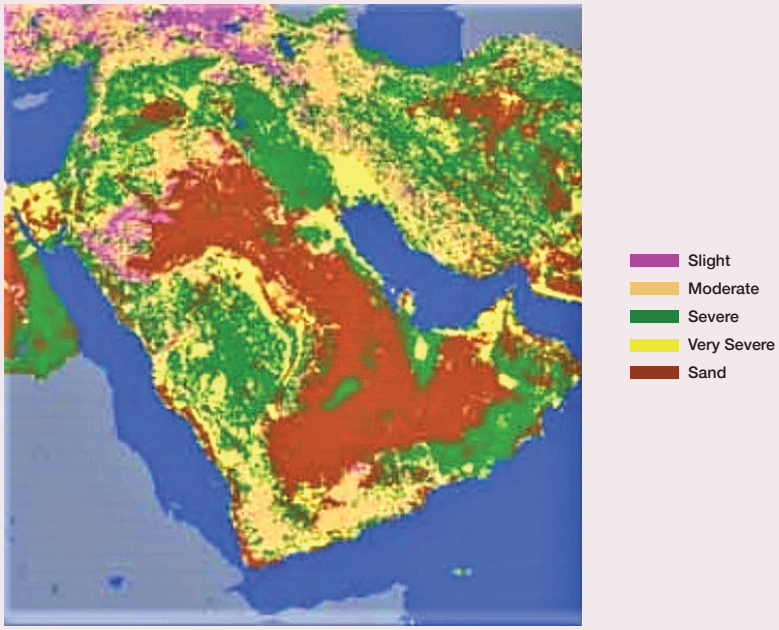
Over 941 municipal solid waste and construction and demolition waste dumpsites in Lebanon[25] were assessed for closure or rehabilitation, with estimated costs for the "top 20" risk-assessed municipal solid waste sites reaching up to US$40 million.

There are opportunities here for investors in clearing and reclaiming land, which in Lebanon is increasing in value. The energy that can be recovered from the dumpsite waste can be sold to local consumers. Lebanon is a net importer of energy,[26] making it subject to market price fluctuations, whereas in many of the Middle East, North Africa, Afghanistan and Pakistan (MENAP) countries, fuel and energy costs are largely subsidized (Coady et al. 2015). Landfill gas is already flared at the Naameh (a site closed in 2015).

Desertification

The climate influences the rate at which waste degrades and generates emissions. This is influenced by the amount of rainwater or precipitation and the moisture content of the waste, which affects changes in methane emissions (Dumble 2017, Dumble et al. 2017).

Figure 17: Vulnerability of the West Asia region to desertification



Source: Harahsheh and Tateishi (2000) with permission of Asian Association of Remote Sensing AARS.[27]

[25] Lebanon Ministry of the Environment [MOEL]/UNDP 2017

[26] See International Energy Agency data for Lebanon at http://www.indexmundi.com/facts/lebanon/indicator/EG.IMP.CONS.ZS

[27] See: at https://a-a-r-s.org/proceeding/ACRS2000/Papers/GLC00-1.htm

There is already credible evidence of significant desertification (see Figure 17) within the West Asia region, as highlighted by Mansour, Saad & Shariff (2011, 1048, Table 2). Approximately 89.6% of the Arabian Gulf region is desertified, with a further 9.0% threatened with desertification, and the Arab Maghreb (the Arab West) 77.7% desertified with a further 16.5% threatened. The impact of this regarding annual methane disposal emissions could be an increase of up to a range of 2.21% to 2.78% in the mixed dry tropical and dry temperate regions of West Asia (Dumble 2017, 229).

Clean Development Mechanism projects in the region and the Green Climate Fund

Developing countries may access the Clean Development Mechanism (CDM) with emission reduction projects that will earn certified emission reduction credits. These are saleable credits to be used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol (UNFCCC Secretariat 2017b).

Table 10: Registered West Asian waste projects under the Clean Development Mechanism

	No. of CDM projects	Project type	Waste management emissions reduction ($MgCO_{2eq}$)
Bahrain	0		0
Iraq	0		0
Jordan	2	Landfill gas recovery; landfill/gas	248,975
Kuwait	0		0
Lebanon	0		0
Oman	1	Compost sewage/green waste	280,000 (according to country representative)
Palestine	0		0
Qatar	0		0
Saudi Arabia	2	Landfill gas capture; landfill/landfill gas	494,533
Syria	2	Landfill gas capture	132,927
UAE	4	Landfill gas (Dubai); landfill gas recovery	308,381
Yemen	0		0

Source: United Nations Framework Convention on Climate Change Secretariat

There are several waste activity Clean Development Mechanism projects throughout the developing countries of West Asia, which concentrate on landfill gas flaring or capture as shown in Table 10. Authorized projects are focused on mitigating:

- landfill methane emissions,
- methane emissions from composting and anaerobic digestion or
- burning organic wastes (to remove methane—methane destruction and methane avoidance).

In dry tropical (GCC countries and Yemen) and dry temperate countries in the Magreb region evapotranspiration is a key factor, as in the hotter seasons with high ground temperatures, rainwater evaporates quickly back into the atmosphere (Rahman et al. 2012; UAE Abu Dhabi Center of Waste Management [CWM] 2010). However, in cooler periods or seasons, leachate is generated because of the rainwater captured within the waste mass, stimulating methane production. Contamination from this leachate spreads into groundwater, worsening the already stressed water resources in West Asia. This is a threat to human health and biodiversity.

A recently developed part of the UNFCCC's financial mechanism, the Green Climate Fund (GCF) also provides developing countries with a way to access public international climate finance.

Chapter 2 References

Abou-Elseoud, N. (2008). "Waste management." In *Arab Environment: Future Challenges (2008 Report of the Arab Forum for Environment and Development),* edited by M.K. Tolba and N.W. Saab, 111–126. Arab Forum for Environment and Development. Available at www.afedonline.org/afedreport/full%20english%20report.pdf

Alghazo, J. & O. Ouda, (2016). Electronic Waste Management and Security in GCC Countries: A Growing Challenge. Conference paper presented at 2nd International Conference on Integrated Environmental Management for Sustainable Development. Available at https://www.researchgate.net/publication/309537926_Electronic_Waste_Management_and_security_in_GCC_Countries_A_Growing_Challenge

Azzi, E. (2017). "Waste Management Systems in Lebanon." Degree project, KTH Royal Institute of Technology School of Architecture and the Built Environment, Sweden.

Baalbaki, R., R. El Hage, J. Nassar, J. Gerard, N.B. Saliba, R. Zaarour, M. Abboud, W. Farah, L. Khalaf-Kairouz, A.L. Shihadeh & N.A. Saliba (2016). Exposure to atmospheric PMs, PAHs, PCDD/Fs and metals near an open air waste burning site in Beirut. *Lebanese Science Journal,* Vol. 17, No. 2 (15 February). Available at https://www.researchgate.net/publication/295398767_Exposure_to_Atmospheric_PMs_PAHs_PCDDFs_and_Metals_near_an_Open_Air_Waste_Burning_Site_in_Beirut

Balde, C.P., F. Wang, R. Kuehr, & J. Huisman (2015). *The global E-waste monitor—2014.* United Nations University. Bonn, Germany: IAS-SCYCLE. Available at https://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

Bhada-Tata, P. & D.A. Hoornweg (2012). What a waste? : A global review of solid waste management. Urban development series knowledge papers; No. 15. Washington, DC: World Bank Group. Available at http://documents.worldbank.org/curated/en/302341468126264791/What-a-waste-a-global-review-of-solid-waste-management

Chin J. (2011). Waste in Asia. Responsible Research Pte. Ltd, Singapore.

Clean Development Mechanism (CDM) to the United Nations Framework Convention on Climate Change, adopted Kyoto, Japan on 11 December 1997. Available at https://unfccc.int/resource/docs/convkp/kpeng.pdf

Coady, D., I. Parry, L. Sears, & B. Shang (2015). How Large Are Global Energy Subsidies? IMF Working Paper, WP/15/105, IMF. Available at https://www.imf.org/external/pubs/ft/wp/2015/wp15105.pdf

COWI (2013). Waste characterization and quantification: Final industrial and hazardous waste survey, Be'ah.

Davis, J.M. & Y. Garb (2018): A strong spatial association between e-waste burn sites and childhood lymphoma in the West Bank, Palestine. *Int. J. Cancer:* 9999, 1–6. Available at https://www.academia.edu/37631693/A_strong_spatial_association_between_e-waste_burn_sites_and_childhood_lymphoma_in_the_West_Bank_Palestine.

Dornier Consulting (2007, 2008, 2009). Treatment and recycling of municipal solid waste in Riyadh, Jeddah, Damman — Kingdom of Saudi Arabia, Phase A-A1 to A-A6 & B-BO to B-B2, 16 February 2007 to 3 July 2009.

Dumble, P. (2011). Waste Management in Abu Dhabi. Lecture presented at the University of Central Lancashire, UK, 3 February.

Dumble, P. (2012). Review of reports on Treatment and Recycling of Municipal Solid Waste in Riyadh, Jeddah and Damman – Kingdom of Saudi Arabia. Prepared on behalf of Ministry of Municipal and Rural Affairs, 2 October.

Dumble P. (2017). Regional development and climate change mitigation modelling of municipal solid waste emissions in the Middle East. *Water and Environment Journal,* Vol.31, No.2, p226-234, May. DOI: 10.1111/wej.12236. Available at http://onlinelibrary.wiley.com/doi/10.1111/wej.12236/full

Dumble, P., N. Karawy, A.O. Abdel-Aziz & A.W. Abolnasr (2017). "Economic and GHG emission policy co-benefits for Integrated Waste Management planning across the GCC." In *Sustainability in the Gulf: Challenges and Opportunities (Routledge Explorations in Environmental Studies),* edited by Elie Azar & Mohamed Abdel Raouf, 228-248. New York: Routledge.

Dumble, P., K.S. Williams & C.N. Lowe (2011). Key Sustainability Criteria Supporting the Development of Abu Dhabi's Integrated Waste Management Systems. *Communications in Waste and Resource Management.* June. Accessed 21/5/2015 at: www.ciwm.co.uk/CIWM/InformationCentre/CWRMJournal/CWRMpapers/CWRM_ Current_Papers.aspx

GIZ and SWEEP-Net (2010a). "Country Report on the Solid Waste Management in Syria." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportSyria-En-mai2011.pdf

GIZ and SWEEP-Net (2010b). "Country Report on the Solid Waste Management in Yemen." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportYemen-En-mai2011.pdf

GIZ and SWEEP-Net (2014a). "Country Report on the Solid Waste Management in Jordan." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/sites/default/files/JORDANIE%20RA%20ANG%20WEB.pdf

GIZ and SWEEP-Net (2014b). "Country Report on the Solid Waste Management in Lebanon." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/sites/default/files/LEBANON%20RA%20ANG%20WEB.pdf

GIZ and SWEEP-Net (2014c). "Country Report on the Solid Waste Management in Occupied Palestinian Territories." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/sites/default/files/PALESTINE%20RA%20ANG%20WEB.pdf

Gulf Petrochemicals and Chemicals Association [GPCA] (2014). A New Horizon for the GCC Plastic Processing Industry. Compiled by Nexant Energy & Chemical Advisory Services. Available at https://gpca.org.ae/2015/01/12/a-new-horizon-for-the-gcc-plastic-processing-industry/

Hussain Harahsheh and Ryutaro Tateishi (2000) Desertification Mapping Of West Asia -A GIS and Remote Sensing Application, ACRS 2000 Proceedings, AARS. Figure 3, Accessed on line 16/11/2019 at https://a-a-r-s.org/proceeding/ACRS2000/Papers/GLC00-1.htm

Intergovernmental Panel on Climate Change [IPCC] (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme. Edited by H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara & K. Tanabe. IGES: Hayama, Japan.

International Quality and Productivity Center [IQPC] (2016). Top waste-to-energy projects in the Middle East. Compiled by IQPC Middle East and the Waste to Energy Middle East, Muscat, Oman. Available at http://www.seas.columbia.edu/earth/wtert/newwtert/assets/news/file/WTE_Middle_East.pdf

Lebanon, Council for Development and Reconstruction [Lebanon CDR] (2015). Collection and Disposal of Municipal Waste in Lebanon. Part IV: Project Information Memorandum. Authored by El-Khoury, R. & Partners.

Lebanon, Ministry of the Environment [MOEL], European Union [EU] & United Nations Development Programme [UNDP] (2014). Lebanon Environmental Assessment of the Syrian Conflict & Priority Interventions. Available at http://www.moe.gov.lb/The-Ministry/Reports/Lebanon-Environmental-Assessment-of-the-Syrian-Con.aspx

Lebanon, Ministry of the Environment [MOEL] & United Nations Development Programme [UNDP] (2011). Preparation of Master Plan for the Clearance and Rehabilitation of Uncontrolled Dumps in Lebanon. Compiled by Earth Link & Advanced Resources Development [ELARD]. Available at http://www.moe.gov.lb/getattachment/Environmental-Guidance/Environmental-Tips/solide_waste_nov2015/Dumps-Final-Report_270511.pdf.aspx

Lebanon, Ministry of the Environment [MOEL] & United Nations Development Programme [UNDP] (2017). Updated Master Plan for the Clearance and Rehabilitation of Uncontrolled Dumps in Lebanon, Volume A. Compiled by Earth Link & Advanced Resources Development [ELARD]. Available at http://www.lb.undp.org/content/lebanon/en/home/library/environment_energy/MASTER-PLAN-FOR-THE-CLOSURE-AND-REHABILITATION.html

Lebanon, Ministry of the Environment [MOEL], United Nations Development Programme [UNDP] & Global Environment Facility [GEF] (2015). National Greenhouse Gas Inventory Report and Mitigation Analysis for the Waste Sector in Lebanon. Available at http://climatechange.moe.gov.lb/viewfile.aspx?id=222

Mansour, A., A. Saad & N.M. Shariff (2011). Estimating Desertification in the Arab World Using GIS Approach. *Middle-East Journal of Scientific Research,* 8(6): 1046-1053. Available at http://www.idosi.org/mejsr/mejsr8(6)11/7.pdf

Nizami, A.S., M. Rehan, O.K.M. Ouda, K. Shahzad, Y. Sadef, T. Iqbal & I.M.I. Ismail (2015). An argument for developing waste-to-energy technologies in Saudi Arabia. *Chemical Engineering Transactions,* 45:337-342.

Ouda, O.K.M., S.A. Raza, A.S. Nizami, M. Rehan, R. Al-Waked & N.E. Korres (2016). Waste to energy potential: A case study of Saudi Arabia. *Renewable & Sustainable Energy Reviews,* 61: 328-340.

Perkins, D.N., M.N.B. Drisse, T. Nxele & P.D. Sky (2014). E-waste: A global hazard. *Annals of Global Health,* 80(4), 286–295. DOI: http://dx.doi.org/10.1016/j.aogh.2014.10.001

Qatar Development Bank (2015). "Qatar: Solid Waste Management, Phase 1 Assessment." Presentation. Retrieved 15 December 2015 from http://www.qsa.gov.qa/eng/News/2013/related/24-62013/Day_1/4_Qatar- Solid%20Waste%20Mgmt%20V5.pdf

Ramboll (2017). Waste Management Assessment for Riyadh, Jeddah, Mecca, Medina and Damman pilot projects. 26 February.

Rahman, M.A., M. Islam, P. Jones, A. Hussain & R.M. Ashfaqur (2012). Recent climate change in the Arabian Peninsula: Seasonal rainfall and temperature climatology of Saudi Arabia for 1979–2009. *Atmospheric Research,* Vol. 111, July, 29-45. doi:10.1016/j.atmosres.2012.02.013.

Ricardo-AEA (2015). Comprehensive Waste Management Programme: Waste Management Strategy (Draft). Prepared on behalf of High Commission for the Development of Riyadh. 16 April.

Sabbagh, M.K. Al-, C.A. Velis, D.C. Wilson, & C.R. Cheeseman (2012). Resource management performance in Bahrain: A systematic analysis of municipal waste management, secondary material flows and organizational aspects. *Waste Management & Research,* 30(8) 813 –824. DOI: 10.1177/0734242X12441962.

Secretariat of the United Nations Framework Convention on Climate Change [UNFCCC Secretariat] (2017a). "Clean Development Mechanism (CDM)." Accessed 2/10/2017 at http://cdm.unfccc.int/

Secretariat of the United Nations Framework Convention on Climate Change [UNFCCC Secretariat] (2017b). "INDCs as communicated by Parties." Accessed 2/10/2017 at http://www4.unfccc.int/submissions/INDC/Submission%20Pages/Submissions.aspx

Tsyenova, O. & M. Bengtsson (2011). Chemical hazards associated with treatment of waste electrical and electronic equipment. *Waste Management,* 31(1), January. https://doi.org/10.1016/j.wasman.2010.08.014

United Arab Emirates, Abu Dhabi Center of Waste Management [CWM] (2010). Landfill Investigation – Al Dhafra, Al Sila, Al Ruwais, Al Ain, Madinet Zyed and Al Mirfa, Emirate of Abu Dhabi, UAE. Authored by C. Welch, B. Dickson, P. Ford, J. Kjoerstad & D. Cramer, SMEC International Pty.

United Arab Emirates, Environment Agency—Abu Dhabi [EAD] & United Arab Emirates, Abu Dhabi Center of Waste Management [CWM] (2013). Towards integrated waste management in Abu Dhabi 2013: Annual Policy Brief. Available at https://www.ead.ae/Documents/PDF-Files/Waste-PB-Eng.pdf

United Nations Development Programme [UNDP] (2011). "Environmental Indicators, waste, municipal waste treatment." Last update March 2011, accessed 14/3/2018 at https://unstats.un.org/unsd/ENVIRONMENT/wastetreatment.htm

United Nations Environment Programme [UNEP] (2016). *GEO-6 Regional Assessment for West Asia.* ISBN: 978-92-807-3548-2. Available at http://www.unep-wcmc.org/news/geo-6-regional-assessments-launched

World Bank (2017a). "GDP." Accessed 20/9/2017 at https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

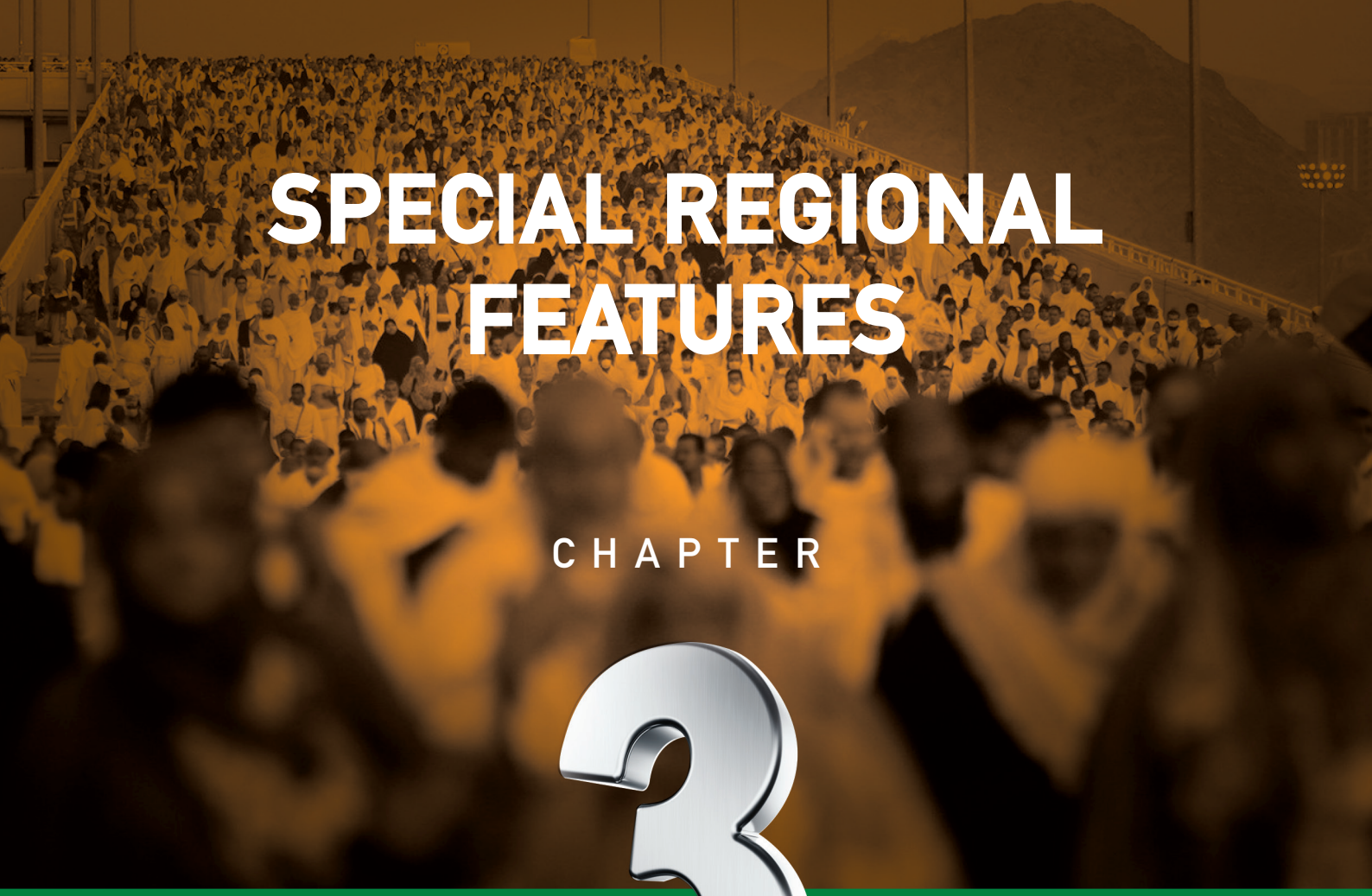
World Bank (2017b). "Population." Accessed 20/9/2017 at https://data.worldbank.org/indicator/SP.POP.TOTL

World Bank (2017c). "Refugee population by country or territory of asylum." Accessed 20/9/2017 at https://data.worldbank.org/indicator/SM.POP.REFG

World Bank (2017d). "Urban population." Accessed 20/9/2017 at https://data.worldbank.org/indicator/SP.URB.TOTL

World Bank (2018). "World Bank Country and Lending Groups." Accessed 14/3/2018 at https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

World Bank, Sustainable Development Department, Middle East and North Africa Region (2011). Republic of Lebanon: Country Environmental Analysis. Report No. 62266-LB. Available at http://documents.worldbank.org/curated/en/360011468265768992/text/622660ESW0Gray0c060601100BOX361480B.txt



SPECIAL REGIONAL FEATURES

CHAPTER

Key messages

West Asia has unique regional features arising from its culture, religion, history and climate that impact waste generation and management across the region. The past and current conflicts in the region produce hazardous, construction and industrial wastes and pollution. Assistance and funding from international donors will be required to address these issues.

Annual festivals such as the Hajj and Ashoura attract immense numbers of pilgrims that generate large amounts of food waste over brief periods. Food waste produced in the region is a significant proportion of the municipal solid waste.

Outlook

This chapter examines issues unique or particularly noteworthy for the region that significantly impact waste generation and management. These include the Hajj in Saudi Arabia, which attracts over 3 million pilgrims over a ten-day period, the religious festival at Kabala in Iraq, which attracts as many as 20 million pilgrims, and other events such as Ramadan, which extends for a lunar month. Conflicts directly or indirectly affect the waste generated in Iraq, Yemen and the bordering countries of Lebanon, Palestine and Jordan within the region. Managing wastes produced by refugees and displaced persons creates significant pressures on the bordering nations. The industrial, hazardous and construction wastes from the pollution and destruction of war create significant challenges for ensuring peaceful, healthy, safe and vibrant communities and will require the assistance of the international community.

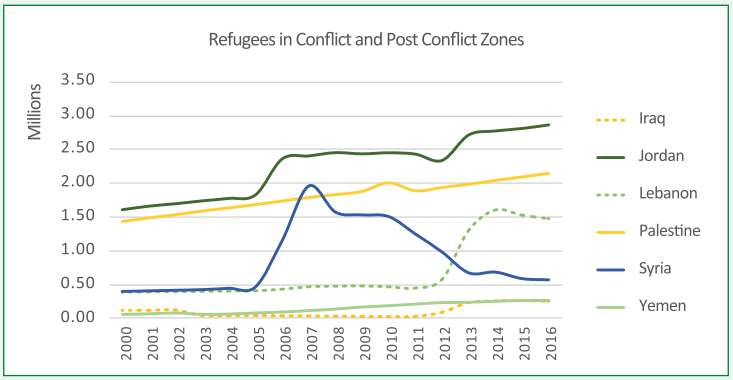
Managing waste in conflict situations: Rebuilding from the ashes

Modern conflicts result in populations that are spread over continents, with many in refugee camps in bordering nations and many others internally displaced. Often homes are destroyed or uninhabitable, with families, including children, becoming the victims of weapons fired, dropped, exploded or placed in the ground. Infrastructure destruction or control is often given priority by the warring factions as part of their efforts to gain military advantage.

CASE STUDY - Impact of refugees on West Asian waste generation

Claimants in West Asia that are officially recognized as refugees under the 1951 Convention Relating to the Status of Refugees or its 1967 Protocol are shown in Figure 18. The chart does not include displaced persons in their own country or refugees that may not be recognized or may not have been processed in the country of destination. The Syrian conflict, which escalated from 2012, saw movement of refugees from Iraq and Syria into the neighbouring West Asian countries of Jordan and Lebanon. The waste generated in Lebanon by refugees in 2014 was 889 tons per day, a figure equivalent to about 15.7% of the total annual municipal solid waste generated before the conflict began (MOEL/EU/UNDP 2014, Lebanon CDR 2015, 26).

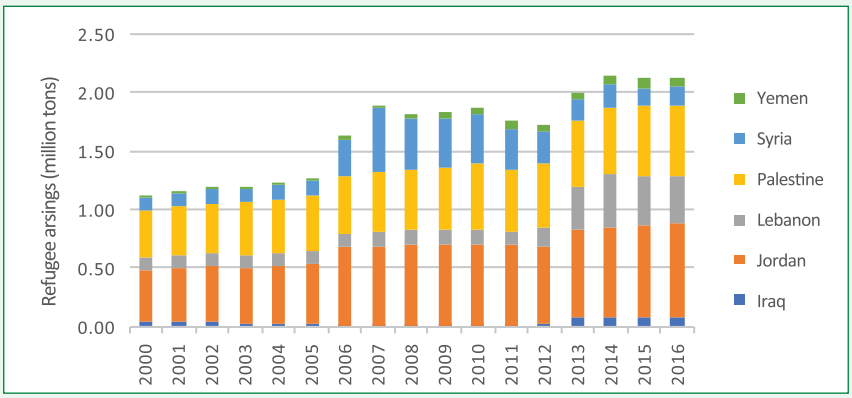
Figure 18: West Asian refugees by country of asylum 2000 to 2016



Source: Data from World Bank, 2017

Using data from the MOEL/EU/UNDP (2014, Table 2.1, 41) report, it is estimated that the waste generation rate of refugees was 279 kg per refugee per year. The regional refugee waste generation in the conflict and post-conflict zones have risen from an estimated 1,117,645 tons in 2000 to 2,119,892 tons in 2016, as shown in Figure 19.

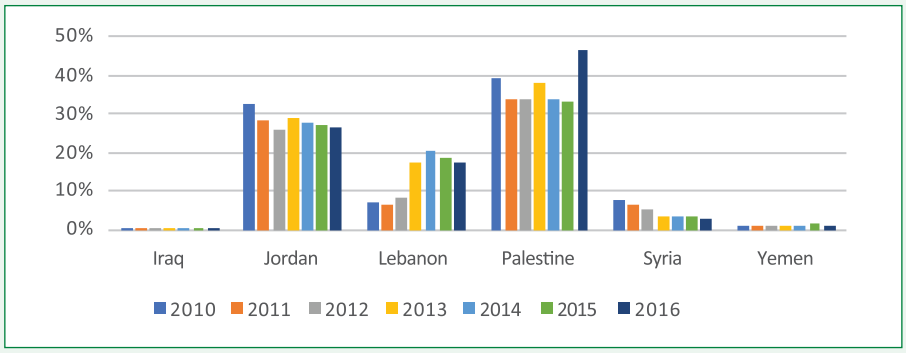
Figure 19: Estimated refugee waste generated in conflict and post-conflict zones of West Asia



Source: Estimated from data in World Bank, 2017 and Lebanon, Ministry of the Environment/European Union/United Nations Development Programme, 2014, 41, Table 2.1

In Lebanon, as the refugees integrate into Lebanese communities, it is expected that the waste generation rate will increase gradually and normalize at the Lebanese municipal solid waste generation rate of 388 kg per capita per year. The impact of refugee waste on the country's total amount of municipal solid waste is shown in Figure 20.

Figure 20: Estimated proportion of countries' municipal solid waste generated by refugees



Source: Estimated from data in Figures 7 & 19

Whilst Jordan has the highest number of registered refugees, the greatest proportion of municipal solid waste generated by refugees is in Palestine, at over 40%.

Handling waste during cultural and religious occasions

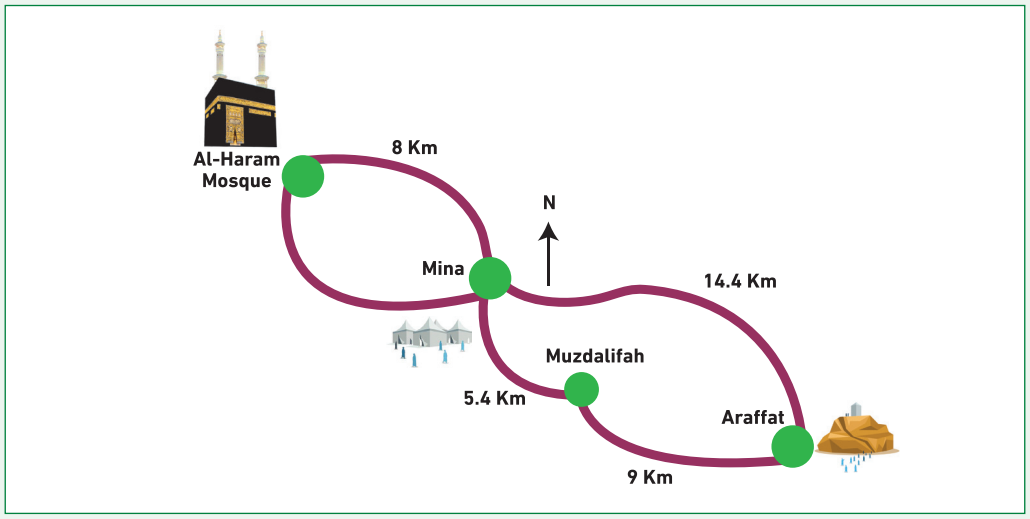
Travel and tourism have become one of the largest and more rapidly growing industries around the world, contributing to an estimated 9% of world GDP and 8% of world employment in 2010. It is estimated that more than 300 million people around the world every year engage in religious tourism, in which people travel to places of religious importance (Hanandeh 2013).

CASE STUDY – The Hajj and religious events in Saudi Arabia

The Muslim pilgrimage to Saudi Arabia is one of the oldest and largest religious gatherings in the world. The holy cities of Mecca and Medina (Madinah) in Saudi Arabia host millions of Muslim worshippers every year from all over the world to perform religious rituals in the forms of the Hajj (pilgrimage), Ramadan (month of fasting) and Umrah. Umrah can be performed at any time of year, in contrast to Ramadan and the Hajj, which are carried out in specific months of the Islamic calendar. The central places of worship during the Hajj, Ramadan, and Umrah are Al-Haram (Holy Mosques in Mecca and Medina) and Al-Masha'ir (Mina, Arafat, and Muzdalifah) of Mecca (Figure 21).

Saudi bulky waste collection (Source: Author)

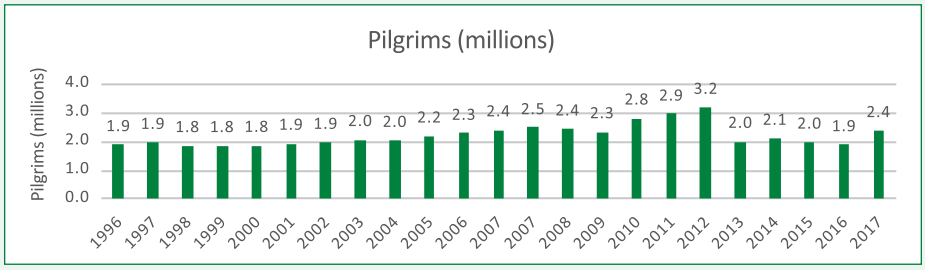
Figure 21: Map of routes and destinations in the Hajj



Source: Co-author Dr. Nizami

The area in and around the Al-Haram mosque in Mecca can accommodate more than 2 million worshippers at a time. A similar number of worshippers can be accommodated in Prophet's Mosque (Al-Masjid an-Nabawi) in Medina. The number of pilgrims visiting Saudi Arabia for the Hajj has increased significantly over the past few decades, at an annual rate of increase of 1.15% from 1993-2014 (Figure 22), requiring the expansion of existing infrastructure and of the two Holy Mosques in Mecca and Medina (Hanandeh 2013). Additionally, in its long-term blueprint for the future, "Saudi Vision 2030," the Saudi government states it is planning to increase the annual number of Umrah visitors from around 8 to 30 million by 2030.[28]

Figure 22: Number of Hajj pilgrims



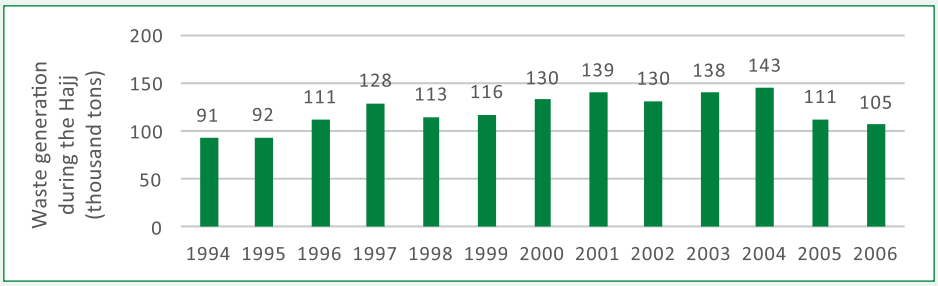
Notes: Figures include both domestic and international visitors.

Source: Saudi Arabia, Central Department of Statistics & Information (CDSI), 2017. "The number of pilgrims for the years from 1996 to 2017." Accessed 1/3/18 at http://www.cdsi.gov.sa

Each year during the Hajj and Ramadan seasons, waste management, including waste collection and disposal, presents a challenging task for the authorities. The landfills in Mecca normally receive about 2,400 tons of municipal waste per day. However, these quantities increase to about 3,100 and 4,600 tons per day during Ramadan and the Hajj, respectively (Nizami et al. 2017). In the 2006 Hajj period, the total waste generated along Hajj routes and destinations was around 105,000 tons (Figure 23).

[28] Saudi Vision 2030 (2016) is available at https://vision2030.gov.sa/en

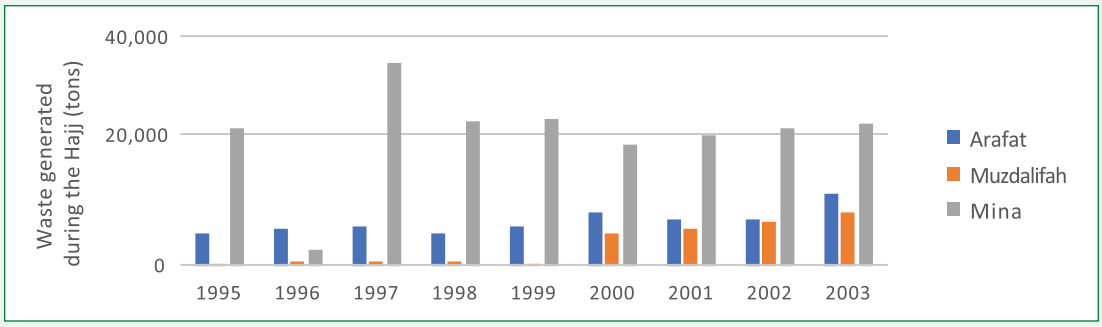
Figure 23: Waste generated during the Hajj



Source: Abdulaziz et al., 2007

The generation of waste peaks during the eighth through thirteenth days of the month of Zul-Hijjah (the month of pilgrimage) and during the final ten days of Ramadan. In Al-Mashair, the maximum generated waste is from Mina because worshippers spend most of their time in Mina during the Hajj period (Figure 24).

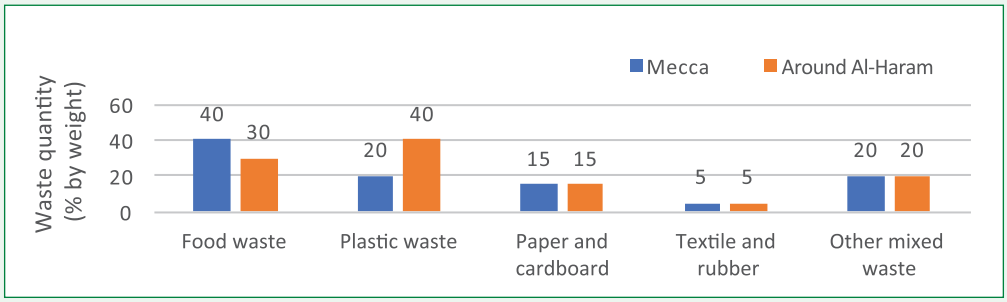
Figure 24: Waste generated during the Hajj period in the Al-Mashair area



Source: Abdulaziz et al., 2007

In 2014, a total estimated amount of 970,000 tons of municipal solid waste was generated in Mecca, including 880,000 tons by the local population, 70,000 tons by Hajj pilgrims and about 20,000 tons by Ramadan visitors. Every year millions of animals are also slaughtered during Hajj season as part of the Hajj pilgrimage. For example, during 2014's Hajj, more than 2.5 million animals were sold for slaughtering (Nizami et al. 2017).

Figure 25: Waste composition in Mecca and around the Al-Haram mosque in Mecca



Source: Abdulaziz et al., 2007

Waste composition across Mecca normally includes food waste (40% minimum by weight), plastics (20% minimum), paper and cardboard (15% minimum), textiles and rubber (5% minimum) and others (20% minimum). However, some aspects of waste composition vary significantly as shown in Figure 25 (Abdulaziz et al. 2007).

The waste in Mecca is collected using metal containers of 4 m^3 capacity, which are distributed around the city by the municipality. Moreover, in commercial and public areas, additional plastic bins having a capacity of 9.5 m^3 are also provided (Alkhuzai 2014). There are several transfer stations in Mecca that receive a daily average of 35 tons of waste, which is transferred to landfill sites. In the Al-Mashair area, there are around 131 underground storage facilities and around 940 compacting containers for storing waste during the Hajj period (i.e., one week). The waste stored at these sites is transferred to landfill sites after the Hajj period finishes (Alkhuzai 2014). The two main landfill sites are unlined sites, the Al-Mis'falah landfill in the south of Mecca with an area of 452,000 m^2, and the Al-Muaisim landfill located in the northeast of Mecca (Alkhuzai 2014). This situation provides significant opportunities for the adoption of sustainable waste management practices.

CASE STUDY – Karbala, Iraq

Karbala is located about 100 km southwest of Baghdad in Iraq. It is designated as a holy city by Shi'ite Muslims and the wider Governorate (Muhafazat) had a resident population of over 1 million in 2010. About 15 million Shi'ite Muslims visit the city to observe Ashura (the tenth day of the month of Muharram), the anniversary of Imam Husayn's death, generating about 4,500 tons per day, or 300g per pilgrim per day, of mainly food waste. Up to 20 million pilgrims attend the second event, Al-Arba'een, that takes place 40 days later, for a period lasting from 15 to 20 days. Pilgrims usually attend on foot from Iraq and countries around the world. The massive scale of the numbers of pilgrims attending puts a significant strain on the city's waste management services,[29] which normally collects a little under 7,600 tons per day.[30]

There are 840 hotels in Karbala that are fully occupied during these events.[31] The waste is collected from additional containers that are placed in the streets during the events and taken to transfer stations, from which they are further transported to dumpsites. In 2014, the Arba'een event is estimated to have generated more than 37,500 tons of waste. More recently almost 58,300 tons[30] were produced daily by up to 18 million pilgrims (Abdulredha et al. 2017), representing about 195 million pilgrim days.

There are opportunities for recycling that are currently being explored with hoteliers to participate in a waste segregation scheme and it is expected that at least 50% of the waste being generated can be recycled. There are no further details on the waste characterization or composition from the study team (Abdulredha et al. 2017). The governorate is developing plans to develop a "good" landfill site, establish a sorting/recycling plant and construct an intermediate transfer station.

[29] See https://uk.news.yahoo.com/millions-end-pilgrimage-iraqs-karbala-145214710.html, and https://en.wikipedia.org/wiki/Karbala accessed 5/4/2018.

[30] Directorate of Karbala Municipality, Division of the Environment and Solid Waste Management

[31] Holy Shrine Authorities

Managing waste in special circumstances: Refugees and war-related waste

At the end of the Gulf War, the oil fields in Kuwait were set alight by retreating forces. Images of these oil fields were shown by media around the world. The damage caused to both land and marine environments was considerable. In the post-war period, the UN engaged with stakeholders to raise funds to address the environmental damage caused. Tenders were invited for the remediation of oil fields and gatch (swelling quartz sand) pits in 2012 and 2017. The approach taken for treatment was related to bioremediation techniques used on the oil-contaminated soils as well as the recovery of oil from the oil fields and gatch pits. Before work could commence, unexploded ordnance (UXO) surveys were undertaken to identify the location of UXO so that the UXO could be neutralized and removed.

Similarly, in post-conflict areas in Iraq, Syria and Yemen, UXO in the form of mines, cluster bombs or booby traps and other types of UXO need to be located, neutralized and removed. This is a highly hazardous activity that has resulted in the deaths of some undertaking these tasks as well as civilians unaware of these hazards. Procedures may involve the careful extraction of civilians and combatants using known or prepared safe routes, and fencing off hazardous areas once military engagements have ceased and then conducting systematic surveys to identify the location of UXO. Specialist UXO teams are then used to identify, neutralize and remove the ordnance.

Post-conflict responses

As conflicts reach the resolution stage, the UN's primary role is to coordinate international support to assist those who have been displaced and those seeking refuge and bring the warring factions together to establish governance and develop plans that will enable the country to return to the international community. International conferences are arranged so that donor countries can provide support and pledge the necessary resources for plans that include the reconstruction and ongoing growth and development of the affected country. The first stage of this involves a series of meetings with the necessary parties to enable an end to hostilities and develop plans to address the damage caused by providing a safe and healthy environment for those affected, displaced or made refugees.

Countries that have already experienced this process include Lebanon after the civil war in 1990, Kuwait and Iraq after the Gulf War, and Palestine, Jordan and Syria after previous conflicts with Israel.

CASE STUDY - Planning to save lives in Yemen

There is an urgent need to reestablish and sustain the livelihoods of local people affected by the conflict in Yemen by implementing quick-impact, multi-dimensional solutions to restore livelihoods and address food insecurity and immediate household needs. The overall goal is are to achieve the sound management of municipal waste, taking into account hazardous waste generated in the conflict, enabling safe restoration and supporting sustainable livelihoods. The plan creates large-scale emergency employment opportunities through a cash-for-work initiative for collecting and disposing of accumulated domestic waste and debris. This will provide opportunities for income to spend on food and other basic household needs. It is also expected to reduce adverse health and hazard impacts, improve basic social services and build trust and confidence within local communities. Key objectives include:

- providing emergency employment and income-earning opportunities to address immediate household needs, including food and other basic needs,
- creating 660,000 labour hours and the injection of $7.7 million directly into the local economies within the targeted areas,
- reducing the risk of the spread of waste-borne diseases such as dengue fever and malaria and

- sustaining and improving the services of basic lifesaving social facilities, especially medical services, through access to reliable solar energy sources.

For solid waste and debris collection and disposal, key objectives are:

- assessing and mapping UXO-affected areas,
- deploying mine action teams to remove UXOs safely,
- setting up temporary intermediate waste collection points, in consultation with local authorities and communities,
- procuring waste collection and protection materials and tools,
- safely demolishing damaged buildings and structures,
- removing and transporting rubble to operating sites,
- collecting and removing solid waste to intermediate collection areas prior to transportation to landfills and dump sites,
- procuring equipment, instruments and materials,
- setting up and operating a vector control system,
- frequently deploying control teams to fog-spray adulticides targeting mosquitoes in waste-contaminated areas. The public authorities use saiperthrin or metathion 57% for this purpose,
- educating the public in the affected areas about mosquitoes and other vectors to help residents protect themselves from disease and
- providing emergency capacity building to the local authorities and undertaking cleanliness projects.

Source: Yemen country representative

Construction waste

Construction waste data for Iraq and Yemen are shown in Table 2 in chapter 2. However, this data excludes much of the data from numerous areas affected by conflict. These numbers are expected to rise significantly in the post-conflict periods as hostilities end in Iraq and Yemen (uncertain) and reconstruction initiatives are established. No construction waste data has been found covering the current situation in Syria.

In their report on Palestine, GIZ/SWEEP-Net stated that 50% of Israel-sourced construction waste enters the West Bank (2014b, 22). “The Ministry [of Environment of Israel] says that at least half of all construction debris is discarded at illegal sites. Much of it is dumped at illegal sites in the West Bank.” The quantities of construction wastes are unknown.

A 2016 survey in Lebanon identified 324 construction and demolition waste dumpsites. Of these, 178 (964,223 m^3) were operational. The total volume of all dumpsites identified was 2,160,536 m^3, with 717,997 m^3 covered and rehabilitated (MOEL/UNDP 2017, 45).

In Jordan, the development of 11.8 million m^2 of building space generates a huge amount of construction waste. Most of this waste is deposited illegally, with some deposited on landowners' sites (permitted by the Ministry of Environment), with the Greater Amman municipality reporting that their disposal sites accept 2.8 million tons annually (GIZ/SWEEP-Net 2014a, 27).

Reconstruction funding and international donors

At an international conference in Kuwait (February 2018) the costs of reconstruction efforts in Iraq were estimated at US$88.2 billion, with short-term expenditures of US$22 billion on the housing sector prioritized (MEMO 2018). US$46 billion of damages was caused to buildings in seven provinces, including 147,000 housing units destroyed in the conflict. The rebuilding of homes, hospitals, schools, roads, businesses and telecommunications is to be prioritized in order to end the displacement of hundreds of thousands. Even more considerable sums were lost due to impacts on the wider economy. Iraq has published 157 projects which require investment, including the airport at Mosul and new investments to diversify the economy away from fossil fuel dependency (Chmaytelli & Hagagy 2018b).

Pledges at the Kuwait conference came to US$33 billion, mainly in credit facilities and investment. Much of this is coming from Middle Eastern countries, including US$1.5 billion from Saudi Arabia and US$11.5 billion from Qatar. Turkey pledged US$5 billion and the United States pledged a further US$3 billion in credit facilities (Chmaytelli & Hagagy 2018a).

The cost of Iraqi reconstruction from 2004 to 2007 was originally estimated at $56 billion. The UN/World Bank and the Coalition Provisional Authority estimated that US$36 billion was needed over the short and medium terms, with the highest consideration to be given to fourteen priority areas including health, education and electricity. The United States had made about US$30 billion available for reconstruction by April 2006, with US$23 billion being obligated and US$16 billion disbursed. Additional pledges from international donors provided a further US$13.6 billion, of which US$900 million was obligated and US$400 million dispersed (Globalsecurity.org 2018).

Conflicts can produce a range of hazardous wastes that need to be dealt with to address the harm that may be caused to people or the environment. These hazardous wastes can arise not only from military waste but also from domestic, trade, industrial, medical, electrical and electronic waste and construction waste streams. Appropriate governance is required to ensure compliance with international conventions and to provide the necessary assurances to international donors funding these processes.

Post-conflict policy and strategy development

Waste management policy needs to be focused on practical, implementable sustainable waste management solutions that will serve post-conflict communities beyond the short and medium terms. Infrastructure development, including sustainable waste management projects, is a priority needing consideration by donor countries at international conferences hosted by the UN to raise funding.

There are significant opportunities to create value from the reuse and recycling of wastes during reconstruction, such as creating value from waste by making use of the lessons learned from best logistics practices and resource efficiency programs in developed countries. This can be enhanced regionally with the lessons learned from good practices gained from the Estidama initiative now being implemented in the UAE[32] and other sustainability initiatives in the GCC countries. Strategies must be based on sustainability concepts that have been demonstrated in developed countries and the West Asia region.

[32] "Estidama" is an initiative in Abu Dhabi, UAE to increase the sustainability of buildings during both operation and construction.

Chapter 3 References

Abdulaziz H., M. Isa, O. Kadir, N. Nordin, W. Daud, A. Alsebaei & A. Abu-Rizaiza (2007). Study of baseline data regarding solid waste management in the holy city of Makkah during Hajj 1427. National Seminar on Hajj Best Practices through Advances in Science & Technology. Centre for Education, Training and Research in Renewable Energy and Energy Efficiency (CETREE), Universiti Sains Malaysia, Penang, Malaysia, May 2007.

Abdulredha, M., R. Al Khaddar, D. Jordan & A. Alattabi (2017). Facing up to waste: How can hotel managers in Kerbala, Iraq, help the city deal with its waste problem? *Procedia Engineering,* Vol.196 (2017) 771-778. https://doi.org/10.1016/j.proeng.2017.08.006

Alkhuzai, K.A. (2014). Use of life cycle assessment (LCA) to develop a waste management system for Makkah, Saudi Arabia. PhD thesis, University of Leeds, UK. Available at http://etheses.whiterose.ac.uk/id/eprint/7906

Chmaytelli, M. & A. Hagagy (2018a). "Allies promise Iraq $30 billion, falling short of Baghdad's appeal." Reuters. February 14. Available at https://uk.reuters.com/article/uk-mideast-crisis-iraq-reconstruction-ku/allies-promise-iraq-30-billion-falling-short-of-baghdads-appeal-idUKKCN1FY12K

Chmaytelli, M. & A. Hagagy (2018b). "Iraq says reconstruction after war on Islamic State to cost $88 billion." Reuters. February 12. Available at https://www.reuters.com/article/us-mideast-crisis-iraq-reconstruction/iraq-says-reconstruction-after-war-on-islamic-state-to-cost-88-billion-idUSKBN1FW0JB

GIZ and SWEEP-Net (2014a). "Country Report on the Solid Waste Management in Jordan." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/sites/default/files/JORDANIE%20RA%20ANG%20WEB.pdf

GIZ and SWEEP-Net (2014b). "Country Report on the Solid Waste Management in Occupied Palestinian Territories." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/sites/default/files/PALESTINE%20RA%20ANG%20WEB.pdf

Globalsecurity.org (2018). "Cost of reconstruction." Accessed on 15/3/2018 at https://www.globalsecurity.org/military/ops/iraq_reconstruction_costs.htm

Hanandeh, A. El (2013). Quantifying the carbon footprint of religious tourism: The case of Hajj. *Journal of Cleaner Production.* 52:53–60.

International Tanker Owners Pollution Federation [ITOPF] (2010). Oil tanker statistics: 2009. Available at http://www.itopf.com/information-services/data-andstatistics/statistics/documents/Statspack2009-FINAL.pdf

International Quality and Productivity Center [IQPC] (2016). Top waste-to-energy projects in the Middle East. Compiled by IQPC Middle East and the Waste to Energy Middle East, Muscat, Oman. Available at http://www.seas.columbia.edu/earth/wtert/newwtert/assets/news/file/WTE_Middle_East.pdf

Iraq, Ministry of Planning, Central Statistical Organization (2010). Demographic Statistics. Available at http://cosit.gov.iq/en/joomla-templates

Lebanon, Council for Development and Reconstruction [Lebanon CDR] (2015). Collection and Disposal of Municipal Waste in Lebanon. Part IV: Project Information Memorandum. Authored by El-Khoury, R. & Partners.

Lebanon, Ministry of the Environment [MOEL], European Union [EU] & United Nations Development Programme [UNDP] (2014). Lebanon Environmental Assessment of the Syrian Conflict & Priority Interventions. Available at http://www.moe.gov.lb/getattachment/6c5fbe66-e28d-4fca-a0ce-3ce92add3f83/Lebanon-Environmental-Assessment-of-the-Syrian-Con.aspx

Lebanon, Ministry of the Environment [MOEL] & United Nations Development Programme [UNDP] (2017). Updated Master Plan for the Clearance and Rehabilitation of Uncontrolled Dumps in Lebanon, Volume A. Compiled by Earth Link & Advanced Resources Development [ELARD]. Available at http://www.lb.undp.org/content/lebanon/en/home/library/environment_energy/MASTER-PLAN-FOR-THE-CLOSURE-AND-REHABILITATION.html

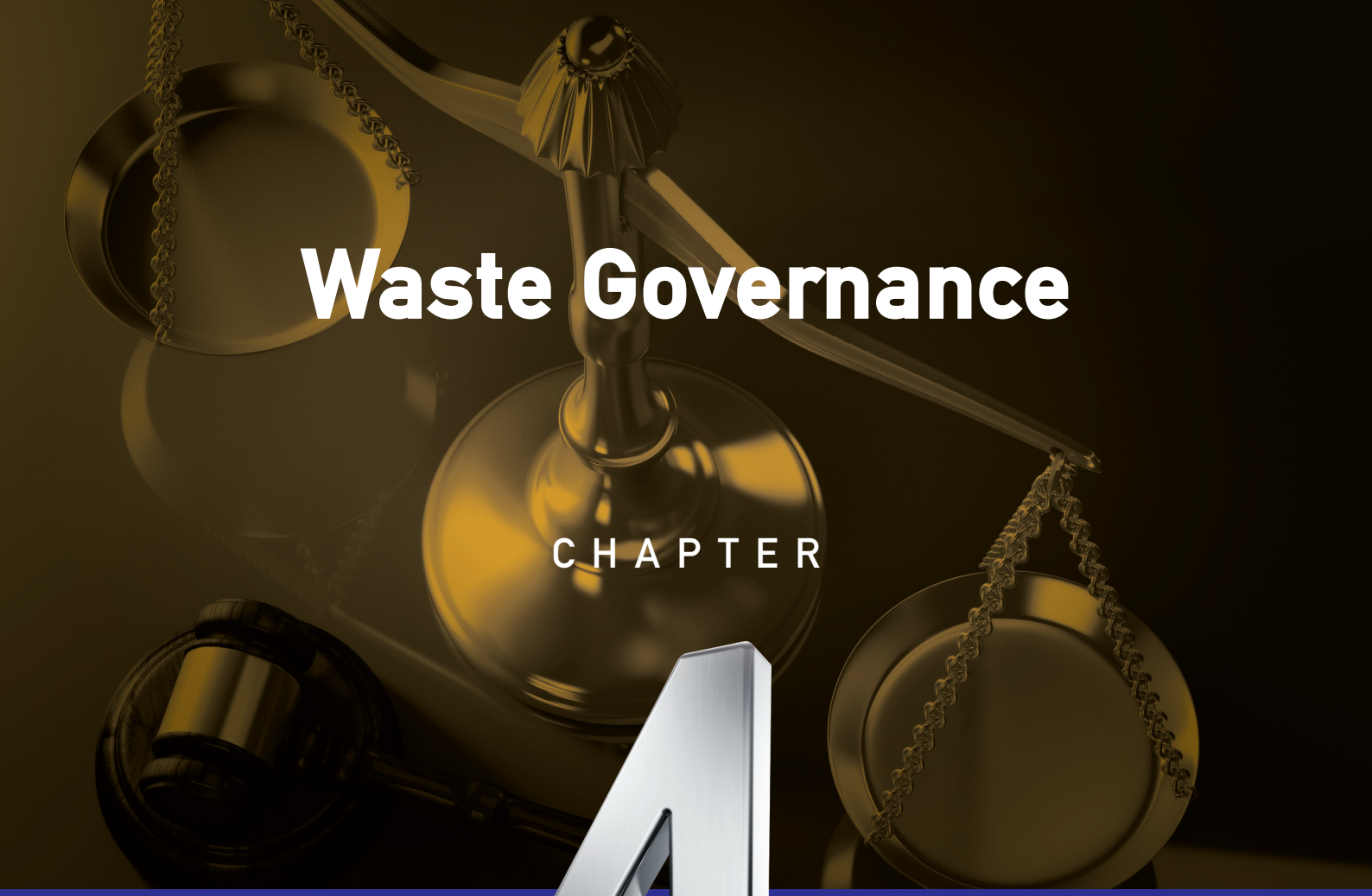
Middle East Monitor [MEMO] (2018). "Iraq: Reconstruction will cost $88.2 billion." Available at https://www.middleeastmonitor.com/20180212-iraq-reconstruction-will-cost-88-2-billion/

Nizami, A.S., M. Rehan, O.K.M. Ouda, K. Shahzad, Y. Sadef, T. Iqbal & I.M.I. Ismail (2015). An argument for developing waste-to-energy technologies in Saudi Arabia. *Chemical Engineering Transactions,* 45:337-342.

Nizami, A.S., K. Shahzad, M. Rehan, O.K.M. Ouda, M.Z. Khan, I.M.I. Ismail, T. Almeelbi, J.M. Basahi & A. Demirbas (2017). Developing waste biorefinery in Makkah: A way forward to convert urban waste into renewable energy. *Applied Energy.* 186(2): 189–196.

World Bank (2017). "Refugee population by country or territory of asylum." Accessed 20/9/2017 at https://data.worldbank.org/indicator/SM.POP.REFG

World Bank (2018). "PCBs." Accessed 20/9/2018 at http://www.worldbank.org/en/news/feature/2017/05/12/lebanon-starts-to-get-rid-of-persistent-organic-pollutants-that-endanger-environment-and-health



Waste Governance

CHAPTER

4

Key messages

There is a need to build the capacity of law enforcement officers and inspectors, especially in ports and in customs, in order to attain compliance with Basel, Rotterdam and Stockholm Convention commitments. Specific legislation, guidance and enforcement are required to address e-waste concerns. Additional regulatory support is necessary for the development of integrated waste management systems and the achievement of the Sustainable Development Goals.

Outlook

This chapter reviews and assesses current waste and environmental management legal and legislative systems in the 12 West Asian countries. It looks at implementation of waste-related international convention commitments as a means of supporting sound waste management, especially regarding hazardous waste, and a holistic approach in the adoption of integrated waste management. The effectiveness of implementation and enforcement is examined by identifying gaps and barriers in light of international commitments.

Sound management of waste and direct regulation

Waste regulation in West Asian countries links directly to international conventions that address the most hazardous or environmentally damaging wastes. UN Environment Programme works with the GCC states to provide the development of common regulations covering the environment, the economy and other areas. Established in 1981, the GCC is an economic bloc for member states Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE. A sub-regional framework for environmental rules and regulations was published in 1997 that is known as General Regulations of the Environment in GCC States.

The legal and legislative framework for waste management systems has been assessed and analysed (Tarek 2017) in a review[33] of the environmental governance of West Asian countries in managing hazardous waste. This has been carried out by:

- indicating the status of implementation of hazardous waste-related international conventions at the national level
- identifying the most outstanding gaps in implementing the commitments that accompany accession to such conventions
- proposing how to address these legislative gaps

Saudi Arabian hazardous waste storage and treatment (Source: Author)

Legislative gaps in West Asian countries' implementation of the Basel Convention

Table 11 indicates the specific definitions of hazardous waste appearing in the national laws of all West Asian countries. The review indicates that they are in line with the provisions of the Basel Convention.

[33] A review of the legislative databases of Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, UAE and Yemen.

Table 11: The availability of specific definitions of hazardous wastes in West Asian countries

State	Legal and legislative status of definitions of hazardous wastes
Bahrain	Law No. (3) of 2006 includes the development of specific definitions of hazardous wastes in accordance with Basel Convention.
	Decree No. (21) of 1996 includes a specific definition of hazardous wastes in accordance with the Basel Convention.
Iraq	Environmental Protection Act No. (27) of 2009 includes the development of specific definitions of hazardous wastes in accordance with the Basel Convention.
Jordan	Environmental Protection Act No. (6) of 2017 includes specific definitions of hazardous wastes in accordance with the Basel Convention.
Kuwait	Environmental Protection Act No. (42) of 2014 includes specific definitions of hazardous wastes in accordance with the Basel Convention.
Lebanon	Environmental Protection Law No. (444) of 2002 includes reference to Cabinet decisions on identifying types and lists of hazardous wastes.
Oman	The Environmental Protection Act issued by Royal Decree No. (114) of 2001 includes specific definitions of hazardous wastes in accordance with the Basel Convention.
Palestine	Environmental Act No. (7) of 1999 includes setting specific definitions of hazardous wastes in accordance with the Basel and Rotterdam Conventions. Also relevant are the decision of the Council of Ministers of 2018 on the System of Hazardous Waste Management and the preparation of a list of hazardous substances and wastes.
Qatar	Environmental Protection Act No. (30) of 2002 includes specific definitions of hazardous wastes in accordance with the Basel Convention.
Saudi Arabia	Mining Investment Regulation No. (47) of 2004 includes specific definitions of hazardous waste in accordance with the Basel Convention.
	The General Environment Law issued by Royal Decree No. (34) of 2001 does not include definitions of waste.
Syria	Safety and Protection of Environment Law No. (12) of 2012 includes specific definitions of hazardous wastes in line with the Basel Convention.
United Arab Emirates	Federal Law No. 24 of 1999 on the protection and development of the environment, as amended by Federal Law No. 20 of 2006, includes specific definitions of hazardous wastes in accordance with the Basel Convention.
Yemen	Environmental Protection Act No. (26) of 1995 includes a specific definition of hazardous wastes in accordance with the Basel Convention.

Source: Tarek 2017

While a suitable legislative structure exists for implementing the commitments of the Basel Convention, there are gaps relating to the control of illicit trans-boundary movements of hazardous wastes and their disposal (Table 12).

More updates and amendments are required to, for example, strengthen environmental protection regulation in countries where the laws (articles and provisions) addressing these commitments were established in some cases more than two decades ago. Over this period, financial penalties have decreased in value and effectiveness. In addition, those who are monitoring the institutional frameworks, the implementation and the enforcement of international convention commitments will need to review and update these laws and supporting regulations.

Table 12: The legal and legislative status of West Asian countries for controlling the illegal trans-boundary movement and disposal of hazardous wastes

Country	Legal and legislative status of the import, export and transit activities of hazardous wastes
Bahrain	Law No. (3) of 2006 prohibits the import, transit or disposal of hazardous wastes. Restrictions were put on the export of hazardous wastes for the purpose of final disposal.
	Law No. (3) of 2006 also includes a classification for hazardous wastes and stipulates the development of a system to monitor and control the handling of hazardous waste and also their export for treatment.
	Decree no. (11) of 1992 was issued to ratify the Basel Convention.
	Decree No. (26) of 2001 was issued to ratify the Regional Protocol on the Control and Disposal of Marine Trans-Boundary Movements and Disposal of Hazardous Wastes and Other Wastes.
	Law No. (8) of 2005 was issued to ratify the amendment of the Basel Convention.
Iraq	Environmental Protection Law No. (27) of 2009 prohibits the disposal of hazardous wastes except in environmentally sound ways.
	Law No. (3) of 2009 was issued for accession to the Basel Convention.
	Law No. (3) of 2015 stipulates hazardous waste management regulations formulated by the Ministry of Health.
Jordan	Law (Environmental Protection Act) No. (6) of 2017 bans the import, introduction or storage of hazardous wastes or materials. It imposes penalties and fines on violators, including prison sentences, and the return of hazardous wastes to their source at the expense of the violators.
	In 2017, the Minister of Municipal Affairs and Environment issued a decree on hazardous wastes banning such wastes from entry.
	In 2003, the Minister of Municipal Affairs and the Environment issued a decree stipulating instructions for the management and handling of hazardous wastes.
	The Minister of Health issued Act No. (1) stipulating instructions for medical waste management.
	In 2017, the Minister of Municipal Affairs and Environment issued a decree stipulating instructions for the electronic tracking of vehicles carrying wastewater and hazardous wastes.
	A Royal decree was passed in 1989 approving accession to the Basel Convention.
	Environmental Protection Law No. (6) of 2017 prohibits the introduction, importation, storage, trade or dumping of hazardous wastes.
Kuwait	Environmental Protection Act No. 42 of 2014, in particular Articles 25-39, establishes control over illegal movement and prohibits the import or export of hazardous wastes and their entry into or transit through Kuwait and sets other restrictions on the handling, storage and disposal of such wastes.
	Executive regulation No. 6 of 2017 of the Environmental Protection Act No. 42 of 2014 was introduced.
	Law No. 25 of 1993 approves accession to the Basel Convention.
	Law No. (10) of 2006 approves the amendment of the Basel Convention.
Lebanon	Environmental Protection Act No. (44) of 2002 prohibits the import, handling or possession of hazardous materials.
	Law No. (71) of 1997 issued by the Minister of Environment establishes the Regulation of the Import of Wastes.
	Law No. (387) of 1994 approves accession to the Basel Convention.
	Law No. (29) of 2015 approves accession to the amendment of the Basel Convention.
	Decree No. (617) of 2017 approves the amendment to the Basel Convention.
	Decree No. (639) of 2014 approves accession to the Protocol on Integrated Coastal Zone Management in the Mediterranean, which includes a detailed protocol for dealing with hazardous wastes in the sea.

Country	Legal and legislative status of the import, export and transit activities of hazardous wastes
Oman	The Basel Convention was ratified by the sultanate of Oman in 1994 by Royal Decree No. (119/94).
	Environment Law issued by Royal Decree No. (114) of 2001 restricts and bans the import and export of hazardous wastes.
	Ministerial Decree No. (79) of 2006 on the specifications and requirements of reservoirs for the conservation of hydrocarbons and dangerous substances was issued.
Palestine	Law No. (7) of 1999 on the Environment bans the import of hazardous wastes into Palestine (Article 13). The law also bans the passage of hazardous wastes through the Palestinian territories, territorial water or economic zones without a permit from SPEQA. The law also imposes prison sentences and penalties on violators.
	Cabinet Decision No. (10) of 2012 on the Medical Waste Management and Handling System was taken.
Qatar	Environmental Protection Law No. (30) of 2002 bans the import, disposal, trans-boundary transfer or movement, and storage of hazardous wastes. The law provides for imprisonment and fines for violators.
	The Executive Regulations of the Environmental Protection Law were issued under the decision of the President of the Supreme Council for Environment No. (4) of 2005, which includes mechanisms for the handling and safe disposal of hazardous wastes.
	Decree No. (15) of 1996 was issued for accession to the Basel Convention.
	Decree No. (36) of 2012 was issued to ratify the Arab Convention against Transnational Organized Crime, which includes hazardous wastes.
Saudi Arabia	The General Regulations on the Environment issued by Royal Decree No. 34 of 2001 ban the introduction of any hazardous wastes, including into territorial waters or the Exclusive Economic Zone. An executive regulation also included the General Regulations on the Environment.
	The penalty for violating such a ban is a fine not exceeding SR 10,000 (approximately US$2,650).
	Royal Decree No. (8) of 1990 ratified the Basel Convention.
Syria	Law on the Protection and Safety of the Environment No. 12 of 2012 bans the import, export or introduction of hazardous wastes, either for disposing such wastes or for another purpose.
	Law No. (26) of 2004 was issued for accession to the amendment of the Basel Convention and to the Basel Protocol on Liability and Compensation for the Damage of Transport of Hazardous Wastes.
UAE	Federal Law No. (24) of 1999 on the Protection and Development of the Environment, amended by Federal Law No. (20) of 2006, prohibits the importing, dumping, storing or disposing of hazardous wastes in the state environment. It also sets penalties of imprisonment and financial fines for violators.
	Federal Decree No. (52) of 1990 was issued for accession to the Basel Convention.
	Federal Decree No. (88) of 2013 was issued for ratification of an amendment to the Basel Convention.
	Federal Decree No. (41) of 2015 was issued for ratification of the Minamata Convention on Mercury.
	Decree of the Minister of Environment and Water No. (152) of 2013 regulates the transit and export of trans-boundary hazardous waste shipments.
	The most important legislation issued in implementation of the Basel Convention is the Executive Regulations on Hazardous Wastes and Medical Wastes issued via Cabinet Resolution No. (37) of 2001, which tackles in detail the handling of hazardous wastes and restrictions on dealing with them.
	Federal Decree No. (77) of 2005 on ratification of the Protocol on the Control of Marine Transboundary Movements and Disposal of Hazardous Wastes and Other Wastes .
	Law No. (21) of 2005 on waste management was issued in Abu Dhabi.
	Law No. (17) of 2008 was issued to establish the Abu Dhabi Waste Management Center.

Country	Legal and legislative status of the import, export and transit activities of hazardous wastes
Yemen	Environmental Protection Act No. (26) of 1995 prohibits the import, export or introduction of hazardous wastes into the State, either for disposing such wastes or for another purpose.
	Law No. (32) of 1990 was issued concerning accession to Basel Convention.
	Law No. (14) of 2006 was issued on accession to the Basel Protocol on Liability and Compensation for Damage Resulting from the Trans-boundary Movements of Hazardous Wastes and their Disposal.

Source: Tarek 2017

The legislative structure in the UAE is advanced and compatible with the changes and updates needed for implementing the commitments referred to in Basel Convention, with national laws reflecting these international commitments at the federal level or at the local level within each Emirate.

Legal and legislative gaps in West Asian countries' implementation of the Rotterdam Convention on Chemicals and Stockholm Convention on Persistent Organic Pollutants (POPs)

The main purpose of the Rotterdam Convention is to promote shared responsibilities and collaborative efforts amongst parties in relation to the international trade of specific hazardous chemical substances. This is to protect human health and the environment from probable harm and contribute in using them in an environmentally sound way by facilitating:

- information exchanges on the properties of chemical substances,
- preparation for national decision making on the imports and exports of chemicals and
- the mainstreaming of such decisions to the parties.

The main purpose of the Stockholm Convention is to protect human health and the environment from persistent organic pollutants (POPs), taking into account the precautionary approach set out in Principle 15 of the Rio Declaration.

Hazardous waste landfill under construction in Kuwait (Source: Courtesy of National Cleaning Company, Kuwait)

Table 13: The legal and legislative status of West Asian countries regarding the Rotterdam & Stockholm Conventions

State	Legal and legislative frameworks of implementation of the Rotterdam Convention on Chemicals and Stockholm Convention on Persistent Organic Pollutants (POPs)
Bahrain	Ministerial Decree No. (7) of 2002 establishes control over the import and use of prohibited or highly restricted chemical substances.
	Act No. (39) of 2005 approves accession to the Stockholm Convention.
	Ministerial Decrees Nos. (3) and (4) of 2006 on hazardous chemicals management and their amendments of 2013 were issued.
	Act No. (14) of 2012 approves accession to the Rotterdam Convention.
Iraq	Act No. (45) of 2015 approves accession to the Stockholm Convention.
	Act No. (46) of 2015 approves accession to the Rotterdam Convention.
	The National Implementation Plan (NIP) for the Stockholm Convention was released in December 2006 and updated in 2013/2014 after a number of new POPs were added to the Convention from 2009 to 2013.
Jordan	Cabinet Resolution No. (1591) of 2003 approves accession to the Stockholm Convention.
	Cabinet Resolution No. (1171) of 2003 approves accession to the Rotterdam Convention.
	Royal Decree of 2015 approves accession to the Minamata Convention on Mercury.
	Soil Protection System of Contaminants No. (25) of 2005 was developed.
Kuwait	Act No. (12) of 2006 approves accession to the Rotterdam Convention.
	Act No. (11) of 2006 approves accession to the Stockholm Convention.
Lebanon	Act No. (728) of 2006 approves accession to the Rotterdam Convention.
	Act No. (570) of 2008 prohibits the import of some agricultural medications in accordance with the Rotterdam Convention.
	Act No. (432) of 2002 approves accession to the Stockholm Convention.
	The National Implementation Plan (NIP) for the Stockholm Convention was developed in 2001. However, as of 2009 the national plan requires updating in order to add new pollutants under the Convention.
Oman	Royal Decree No. (81) of 1999 approves accession to the Rotterdam Convention
	Royal Decree No. (117) of 2004 approves accession to the Stockholm Convention.
	The National Implementation Plan (NIP) for the Stockholm Convention was developed in 2009.
Palestine	The Stockholm and Rotterdam Conventions were signed in 2018.
Qatar	The Executive Regulation of the Environment Protection Act was issued by the Chairman of the Supreme Council for the Environment as Decision No. 4 of 2005.
	The National Implementation Plan (NIP) for the Stockholm Convention was developed in 2010.
Saudi Arabia	Royal Decree No. (22) of 2000 approves accession to the Rotterdam Convention.
	Royal Decree No. (35) of 2002 sets out the system for trading in agrofertilizers.
	Royal Decree No. (38) of 2006 sets out a system for importing and managing chemicals.
Syria	Decree No. (35) of 2003 approves accession to the Rotterdam Convention.
	Decree No. (54) of 2005 approves accession to the Stockholm Convention.
	The National Implementation Plan (NIP) for the Stockholm Convention was developed in March 2009.

State	Legal and legislative frameworks of implementation of the Rotterdam Convention on Chemicals and Stockholm Convention on Persistent Organic Pollutants (POPs)
United Arab Emirates	Federal Decree No. (28) of 2002 approves accession to the Stockholm Convention.
	Federal Decree No. (47) of 2002 approves accession to the Rotterdam Convention.
	Federal Decree No. (41) of 2015 approves accession to the Minamata Convention.
	Minister of Environment Decision No. (783) of 2015 stipulates the industrial chemicals prohibited and restricted from use.
	Minister of Environment Decision No. (137) of 2012 stipulates guidelines for cement industry facilities.
	The National Implementation Plan (NIP) for the Stockholm Convention was developed in October 2008, with subsequent amendments issued in April 2015.
Yemen	Act No. (25) of 1999 sets out regulations for handling agricultural pesticides.
	Act No. (9) of 2005 approves accession to the Rotterdam Convention.
	The National Implementation Plan (NIP) for the Stockholm Convention was developed in January 2016.

Source: Tarek 2017

Bridging legislative gaps in implementing the international conventions related to hazardous waste

Table 13 and Table 14 show the status of legislation for the implementation of the Rotterdam and Stockholm Conventions in each West Asian country. Under the Stockholm Convention, the most important commitments are the control of imports, exports, production and usage of specific chemicals according to the annexes attached to the Convention, ensuring environmentally sound disposal and developing a national implementation plan (NIP) for the provisions of the Convention. Although most West Asian countries have already developed their NIPs, the additional listing and updating of POPs since 2009 has resulted in countries needing to review and update their NIPs, an undertaking which only Jordan and the UAE have completed.

CASE STUDY: Stockholm Convention compliance for POPs in Lebanon

Lebanon exported 91 tons of persistent organic pollutants (POPs) known as PCBs (polychlorinated biphenyls) in December 2016. PCBs used to be used as dielectric fluids in old power transformers and their toxicity is classified as carcinogenic and teratogenic. Equipment containing PCBs was identified and collected from power plants and substations around Lebanon by a specialist contractor. The transport of the equipment to France was tracked and destruction of the waste by high temperature incineration was certified.

The collection and export of this hazardous waste was made possible through Global Environment Facility (GEF) grant financing that is available to countries that have ratified the Stockholm Convention. The key stakeholders in this partnership are the GEF and the World Bank Group, with local partner Electricité du Liban (EDL). There are further efforts to identify other transformers and capacitors and establish a national inventory of these hazardous wastes.

Source: World Bank, 2017

Table 14: West Asian countries' status in implementing the provisions of the Basel, Rotterdam, and Stockholm Conventions

State	Basel Convention Commitments		Rotterdam Convention Commitments		Stockholm Convention Commitments	
	General Environment Act	Direct legislation for implementing the convention	General Environment Act	Direct legislation for implementing the convention	General Environment Act	Direct legislation for implementing the convention
Bahrain	√*	√*	√*	√*	√*	
Iraq	√*	√*	√*		√*	√*
Jordan	√	√	√	√*	√	√*
Kuwait	√	√	√	√*	√	√*
Lebanon	√*	√*	√*	√*	√*	√*
Oman	√*	√*	√*	√*	√*	√*
Palestine	√*	√	√*		√*	
Qatar	√*	√*	√*	√*	√*	√*
Saudi Arabia	√*	√*	√*	√*	√*	
Syria	√*	√*	√*	√*	√*	
United Arab Emirates	√*	√	√*	√	√*	√
Yemen	√*		√*	√*	√*	√*

Notes: * Exists but requires amendments √ Includes implementation No entry: No suitable legislation exists

Source: Co-author Dr. Tarek

The legislative gaps in West Asia countries' implementation of the Rotterdam Convention are indicated in Table 14. One of the most important commitments under the Rotterdam Convention is that each Party shall implement appropriate administrative and legislative measures to ensure timely decisions with respect to the import of chemicals that are listed in Annex III of the Convention. Despite West Asian countries enacting legislation on chemicals to implement the Convention, further amendments are required, as well as the updating and enforcing of measures that impose penalties and fines. Institutional coordination is also required at the national level between relevant bodies dealing with chemicals, such as the ministries of health, industry, agriculture, interior (customs) and environment, and with other entities.

Recommendations

The key issues to be addressed and actions to be taken are:

1. developing the capacity of law enforcement officers and inspectors, especially in ports and in customs, training them to deal with hazardous wastes and chemicals, and reaping benefits from Kuwait's hosting of the Stockholm Convention Regional Centre for Capacity-Building and the Transfer of Technology (SCRC-Kuwait),
2. developing direct legislation to implement the three conventions (Basel, Rotterdam and Stockholm) and reducing sole reliance on environmental law articles that are or may be used to implement the provisions of the three conventions,
3. confiscating hazardous wastes or chemicals and returning them to their source at the expense of the violator,
4. issuing direct and special legislation for classifying wastes in general and e-wastes in particular,

5. updating environmental protection laws and
6. addressing the importance of environmentally sound management of POPs by issuing updated and appropriate legislation, especially to include the POPs added to the Stockholm Convention since 2009.

Other international conventions

Marpol Convention: The Marpol Convention is the principal international convention covering the prevention of pollution of the marine environment by ships from operational or accidental causes. The Convention looks at the provision of facilities for shipping wastes and the tracking of wastes to avoid the dumping of wastes at sea. Its main objective is to preserve the marine environment by completely eliminating pollution by oil and other harmful substances and minimizing accidental discharges of such substances.

Montreal Convention: The Montreal Protocol is humankind's most effective multilateral environmental action to date in controlling and reducing ozone-depleting emissions from the environment, allowing the atmospheric ozone layer to recover and protecting us from damaging radiation from the sun. This Protocol is relevant to waste management because substances used in air conditioning units and as refrigerants may be ozone-depleting and may still be present in waste equipment in West Asian countries.

Waste collection bin at portside (Source: Author)

Minamata Convention: The Minamata Convention, which was adopted and opened for signature in 2013, controls activities related to mercury emissions, including activities such as burning wastes and coal, manufacturing and mining.

United Nations Framework Convention on Climate Change: The UNFCCC entered into force on 21 March 1994 and currently there are 197 Parties to the Convention. The Convention was one of three adopted at the Rio Earth Summit in 1992. These are linked, with the other two being the UN Convention on Biological Diversity and the Convention to Combat Desertification. Historically, desertification has been a key issue in the West Asia region (UNFCCC Secretariat 2017; Mansour, Saad & Shariff 2011). West Asian countries, Bahrain, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar and the UAE have ratified the Climate Change accord of the COP21: UN Conference on Climate Change held in Paris in 2015.

West Asian waste policy, regulation, strategy and planning

Table 15 indicates some confusion in defining municipal solid waste, as noted in chapter 2, where commercial, trade waste and agricultural wastes may be included in municipal solid waste inventories. The UAE has specific legislation and codes of practice, technical guidance and technical standards that are linked through an article in the legislation referring to these instruments and providing legal recognition. In many cases, a change in the law is not required to introduce a new code of practice, guidance or specification. Such changes are usually implemented by the competent waste authority and authorized by the national environmental entity. Enforcement usually takes the form of "No objection" statements for non-waste sector entities or permitting conditions for waste sector entities.

Table 15: West Asian countries' status in classifying and managing waste

State	Non-hazardous industrial wastes	Medical waste	Construction waste	Solid and household waste	Municipal waste	E-waste
Bahrain	√	√	√		√	
Iraq			Only guidelines	√	√	
Jordan	√	√		√	√	
Kuwait	Only within the environment law	√	√	√	√	
Lebanon	√	√	√	√	√	
Oman			√	√	√	
Palestine		√	√	√		
Qatar	√	√	√	√	√	
Saudi Arabia	Only within General Regulations on the Environment	√	√	√	√	
Syria	√	√			√	
UAE	√	√	√	√	√	
Yemen			√			
Key: √ - legislation adopted, No entry: - legislation not prepared or not yet implemented						

Source: Co-author Dr. Tarek

The issues impeding effective policy implementation and hampering adequate translation into the necessary waste infrastructure and capacity to fulfil the visionary approach of regional governments (Ansari 2012) have been evident for many years. It has been noted that while some Arab countries have adopted an integrated environmental management approach, they still lack the statistics, strategies, plans and financial resources to undertake integrated environmental management successfully (Abou-Elseoud 2008, 125). There is also a need to build capacity in the sound management of chemicals and waste (Gelil 2014, 11). Development of necessary policy, regulation, implementation and enforcement measures for e-waste is a key focus for governments that is identified in the legislative review shown in Table 15. This is confirmed by issues of poor practice and detrimental impacts on health identified throughout this Regional Outlook.

Strategies and master plans have been developed in Palestine, Syria and Yemen (GIZ/SWEEP-Net 2010a & 2010b; Arif 2012). Draft policies and strategic waste management solutions are currently being developed in Lebanon and Jordan. Municipal solid waste laws have been enacted in Syria, and draft waste management laws have been prepared in Lebanon, Palestine and Yemen, awaiting enactment.

Up until recently Lebanon has been at the forefront in this region in the development of policies, strategies, regulations and planning to advance the adoption of integrated waste management systems, ahead of the high-income GCC countries.

Table 16: Progress in the development of integrated waste management policy measures

Country	Policy	Strategy	Regulatory	Planning
Bahrain		Under development[1]		Under development[1]
Iraq		Established[2]		Under development[2]
Jordan	Under development[3]	Under development[3]	Under development[3]	
Kuwait		Under development[4]		Under development[4]
Lebanon	Established[6]	Established[6]	Established[6]	Implemented[6, 7]
Oman				Implemented[8]
Palestine	Under development[9]	Under development[9]	Under development[9]	Under development[9]
Qatar				Implemented[10]
Saudi Arabia				Under development[5]
Syria	Under development[11]		Under development[11]	
UAE				Implemented[12]
Yemen	Under development[13]		Under development[13]	

Notes: 1. Ansari (2012). 2. Iraq is known to have undertaken strategic planning that was delayed and affected by recent conflicts. EEA (2015). 3. GIZ/SWEEP-Net (2014a). 4. Strategic road map and planning (2018). 5. Dumble (2012). 6. Lebanon CDR (2015). 7. World Bank (2011). 8. Harthy (2016). 9. GIZ/SWEEP-Net (2014b). 10. Domestic Solid Waste Management Centre at Mesaieed (operational from 2012). 11. GIZ/SWEEP-Net (2010a). 12. A number of sorting and composting plants have been developed including one in the Emirate of Sharjar (see "UAE Waste facility in Sharjah" at https://www.youtube.com/watch?v=SnxpfS_4PYg) 13. GIZ/SWEEP-Net (2010b).

Source: Compiled by Author

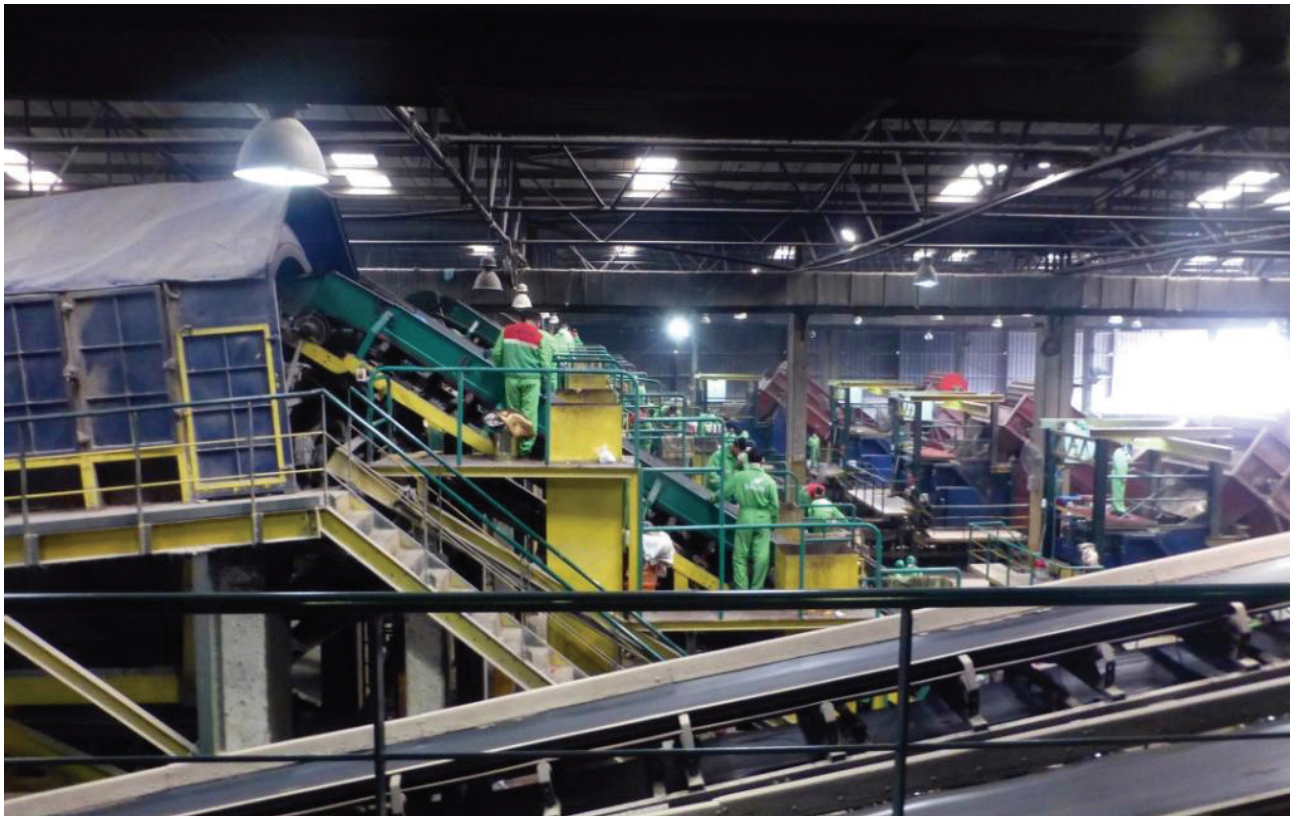
However, the GCC countries have been catching up with Lebanon, with Qatar and the UAE starting to focus on the development of integrated waste management treatment facilities. In the Emirate of Abu Dhabi, codes of practice, technical guidance and standard operating procedures have regulatory status in Law #21 of 2005 concerning waste management, which covers hazardous and non-hazardous waste. Other or new integrated waste management treatment technologies, guidance, methods and standards can be proposed and approved by the competent authority.

Saudi Arabia is currently developing plans to support national strategies with a focus on protecting the environment from harmful emissions from contaminated land or from disposal in unlined dumpsites. These plans will form part of the National Environment Strategy for the Kingdom of Saudi Arabia—Waste Management and Chemical Safety.

As a small island state, Bahrain has perhaps the most significant challenge, with disposal of municipal waste taking place in the center of the island at the Askar dumpsite. There are plans for the development of a National Waste Management Strategy and in terms of integrated waste management implementation, a recent permit application for a Waste 2 Energy facility failed to win approval with a government entity, illustrating policy barriers that need to be overcome.

Implementation and enforcement

Most West Asian countries monitor and enforce waste management regulations through contract management or through a permit processes. This involves the use of inspectors that monitor street cleaning and collection services. In some GCC countries including the UAE, upon identifying an incident such as waste containers not being emptied or illegal tipping, the inspector may use a data logger to record the waste type and incident, photograph and record the time, locate the incident using geographic information system (GIS) coordinates and then send to the service provider an email that includes the report details and photograph and require the provider to act within 24 hours. Failure by the contractor to respond is a contractual default subject to financial penalties. These electronic enforcement systems are becoming more widespread across the region.



Karantina Mechanical Sorting Facility in Lebanon (Source: Author)

Linking the Sustainable Development Goals to waste management issues

In the immediate future, prospects for plastic recycling will be limited by available recycling capacity and increases in primary petrochemical production of plastics in the US and the high quality standards recently set by China for importing post-consumer recyclables. With 40% to 45% of GDP dependent on plastics in most GCC countries (GPCA 2014), it is likely that the GCC countries and Iraq (also a major oil producer), despite their environmental and cost reservations, are more likely to adopt waste to energy or the lower cost option of sanitary landfill disposal in order to protect their plastic markets. Other West Asian countries will continue to recycle plastics, sending their recycling increasingly toward Eastern Europe and Turkey.

The Sustainable Development Goals relate to addressing:

- public health issues through increased coverage of waste collection to reach 100% of all residents (particularly relevant to Sustainable Development Goals [SDGs] 1.2, 11.1, 11.6)
- environmental issues
  - o phasing out of dumpsites (SDGs 6.3,11.6, 12.4)
- environmental & socio-economic issues
  - o adoption of the 3Rs of “reduce,” “reuse” and “recycle” (SDGs 1, 8, 9, 12.5)
  - o sound management of all wastes, and hazardous wastes in particular (SDGs 7, 12, 4, 13)
  - o halving of per capita food waste (SDGs 2, 12.3)

Chapter 4 References

Abou-Elseoud, N. (2008). Waste management. In *Arab Environment: Future Challenges (2008 Report of the Arab Forum for Environment and Development).* Edited by Mostafa K. Tolba and Najib W. Saab, 111–126. Available at www.afedonline.org/afedreport/full%20english%20report.pdf

Ansari, S.M. Al (2012). Improving solid waste management in Gulf Co-operation Council states: Developing integrated plans to achieve reduction in greenhouse gases. *Modern Applied Science,* 6(2) (February): 60–68. doi:10.5539/mas.v6n2p60

Arif, S. (2012), "The solid wastes management situation in Mashreq and Maghreb countries, Update on challenges and opportunities." Accessed 2/12/2015 at http://www.giz.de/en/downloads/giz2012-enSWEEP-Netregional-report.pdf

Dumble, P. (2012). Sustainability indicators as a planning tool for waste technology applications. Research lecture at University of Central Lancashire, UK, 7 February.

European Union, European Environment Agency (2015). Development of a waste management information system with integrated possibilities for adjusting it to a specific IT-supported system corresponding to the country's needs: Assessment Report. SEIS Jordan Technical Assistance Action 2 (TA2), Draft 01.

Gelil, I.A. (2014). Proposal for an Arab Strategic Framework for Sustainable Development, 2015–2025. Arab High Level Forum on Sustainable Development, Economic and Social Commission for Western Asia (ESCWA), Amman, Jordan, 2–4 April. Available at http://css.escwa.org.lb/SDPD/3315/2.pdf

GIZ and SWEEP-Net (2010a). "Country Report on the Solid Waste Management in Syria." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportSyria-En-mai2011.pdf

GIZ and SWEEP-Net (2010b). "Country Report on the Solid Waste Management in Yemen." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportYemen-En-mai2011.pdf

GIZ and SWEEP-Net (2014a). "Country Report on the Solid Waste Management in Jordan." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/sites/default/files/JORDANIE%20RA%20ANG%20WEB.pdf

GIZ and SWEEP-Net (2014b). "Country Report on the Solid Waste Management in Occupied Palestinian Territories." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/sites/default/files/PALESTINE%20RA%20ANG%20WEB.pdf

Gulf Petrochemicals and Chemicals Association [GPCA] (2014). A New Horizon for the GCC Plastic Processing Industry. Compiled by Nexant Energy & Chemical Advisory Services. Available at https://gpca.org.ae/2015/01/12/a-new-horizon-for-the-gcc-plastic-processing-industry/

Harthy, M. Al (2016). Transformation of Waste Management in Oman. Presentation to ISWA Energy Recovery Working Group Meeting, West Palm Beach, FL, USA, 25 May.

Lebanon, Council for Development and Reconstruction [Lebanon CDR] (2015). Collection and Disposal of Municipal Waste in Lebanon. Part IV: Project Information Memorandum. Authored by El-Khoury, R. & Partners.

Lebanon, Ministry of the Environment (2016). Support to Reforms – Environmental Governance, Beirut, Lebanon: Assessment of Solid Waste Management Practices in Lebanon in 2015. Project Identification No. EuropeAid/134306/D/SER/LB/3, Service Contract No: ENPI/2014/337-755. Compiled by GFA Consulting Group-led consortium. Available at www.moe.gov.lb/getattachment/ddd7eb2d-ccc2-4e7d-af0a-ea39562544c2%2F.aspx

Lebanon, Ministry of the Environment & United Nations Development Programme [UNDP] (2011). Preparation of Master Plan for the Clearance and Rehabilitation of Uncontrolled Dumps in Lebanon. Compiled by Earth Link & Advanced Resources Development [ELARD]. Available at http://www.moe.gov.lb/getattachment/Environmental-Guidance/Environmental-Tips/solide_waste_nov2015/Dumps-Final-Report_270511.pdf.aspx

Lebanon, Ministry of the Environment & United Nations Development Programme [UNDP] (2017). Updated Master Plan for the Clearance and Rehabilitation of Uncontrolled Dumps in Lebanon, Volume A. Compiled by Earth Link & Advanced Resources Development [ELARD]. Available at http://www.lb.undp.org/content/lebanon/en/home/library/environment_energy/MASTER-PLAN-FOR-THE-CLOSURE-AND-REHABILITATION.html

Lebanon, Ministry of the Environment, United Nations Development Programme [UNDP] & Global Environment Facility [GEF] (2015). National Greenhouse Gas Inventory Report and Mitigation Analysis for the Waste Sector in Lebanon. Available at http://climatechange.moe.gov.lb/viewfile.aspx?id=222

Tarek, I. (2017). Towards a Strategy and Action Plan for Environmental Governance in the Arab Countries. Report submitted to the Arab League.

Saad, A.M.A. & N.M. Shariff (2011). Estimating Desertification in the Arab World Using GIS Approach. *Middle-East Journal of Scientific Research,* 8(6): 1046-1053, (2011) ISSN 1990-9233. Available at http://www.idosi.org/mejsr/mejsr8(6)11/7.pdf

Secretariat of the United Nations Framework Convention on Climate Change [UNFCCC] (2017). First steps to a safer future: Introducing The United Nations Framework Convention on Climate Change. Retrieved 7 October 2017 from http://unfccc.int/essential_background/convention/items/6036.php

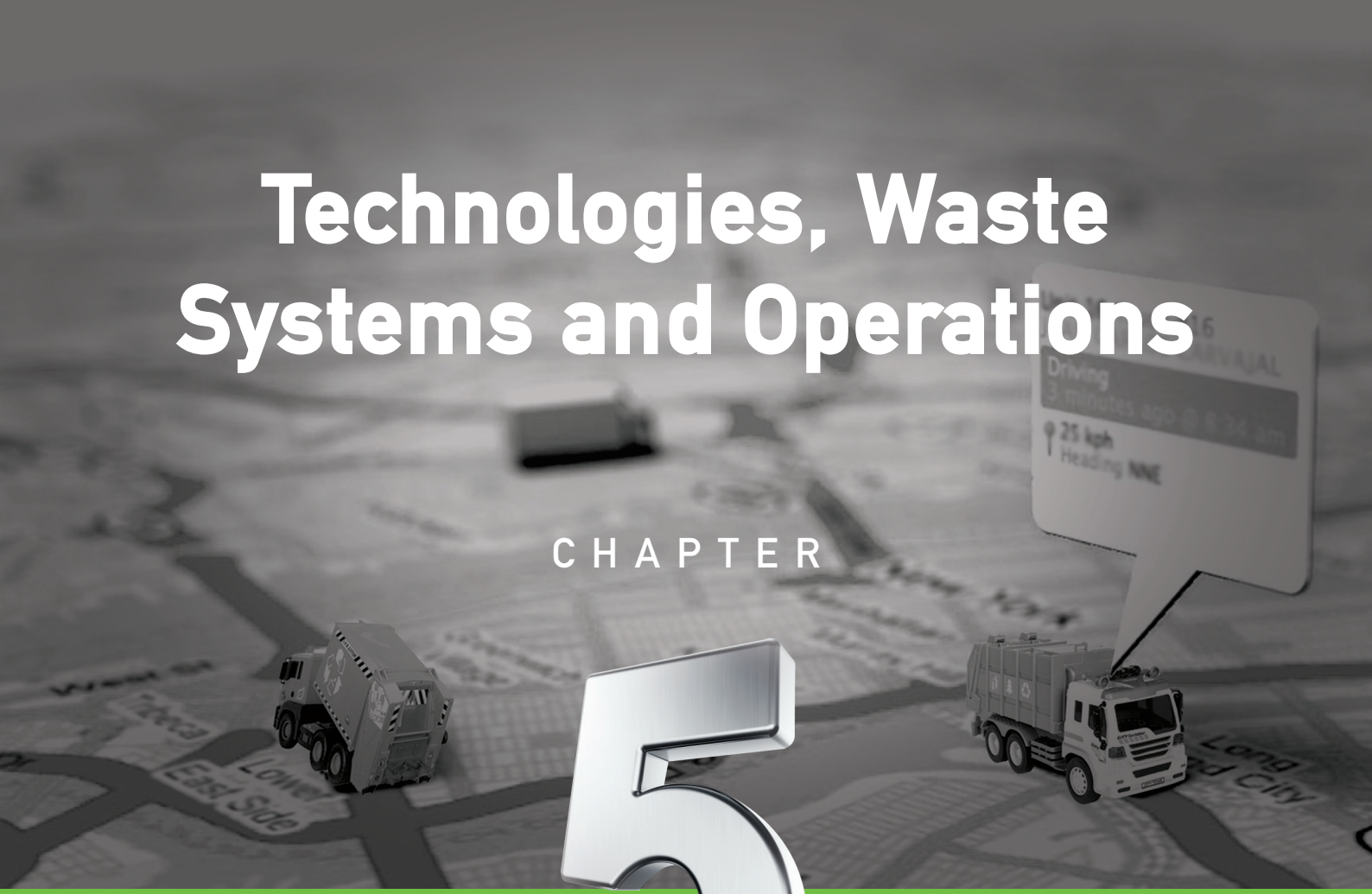
United Nations [UN] (2016). Full Implementation of 2030 Agenda for Sustainable Development Requires Reaching Those Furthest Behind, Secretary-General Tells High-Level Political Forum, ECOSOC/6787, 19 July 2016. Available at http://www.un.org/press/en/2016/ecosoc6787.doc.htm

United Nations Environment Programme [UNEP] (2016). *GEO-6 Regional Assessment for West Asia.* ISBN: 978-92-807-3548-2. Available at http://www.unep-wcmc.org/news/geo-6-regional-assessments-launched

World Bank (2017). “Lebanon Starts to Get Rid of Persistent Organic Pollutants that Endanger Environment and Health.” 12 May. Available at http://www.worldbank.org/en/news/feature/2017/05/12/lebanon-starts-to-get-rid-of-persistent-organic-pollutants-that-endanger-environment-and-health

World Bank, Sustainable Development Department, Middle East and North Africa Region (2011). Republic of Lebanon: Country Environmental Analysis. Report No. 62266-LB. Available at http://documents.worldbank.org/curated/en/360011468265768992/text/622660ESW0Gray0c060601100BOX361480B.txt

Technologies, Waste Systems and Operations



CHAPTER

5

Key messages

It is difficult to conduct effective waste management when lacking access to adequate data. The emergence of smart waste systems that have already been adopted in the Emirate of Abu Dhabi provide effective, efficient and real-time monitoring of waste and the movement of recyclables, tariff collection, performance management and regulatory compliance. Appropriate treatment technologies must be chosen to address the generally higher moisture content of municipal solid waste in West Asian countries.

Outlook

This chapter examines the evolution of data management systems for waste management in West Asian countries. These smart waste systems will support and improve the selection, efficiency, quality and performance of collection facilities while also promoting appropriate waste monitoring, sorting and treatment technologies. An integrated waste management technology framework is proposed to enable decision makers to address current treatment issues and maximize value derived from the treatment of municipal solid waste.

“Without data you cannot manage effectively.”

In any management system, data is critical for effective management and control. Without data, managers must rely on their best guesses and interpretations. Lack of data is often used to justify a failure to act or maintenance of the status quo. These statements provide an overview of the historical situation in many West Asian countries. However, circumstances are starting to change along with the significant development of data management systems in the UAE and Saudi Arabia. Such systems are also now under consideration in Bahrain, Jordan, Lebanon and Oman.

Technologies are used across the whole range of waste management activities from:

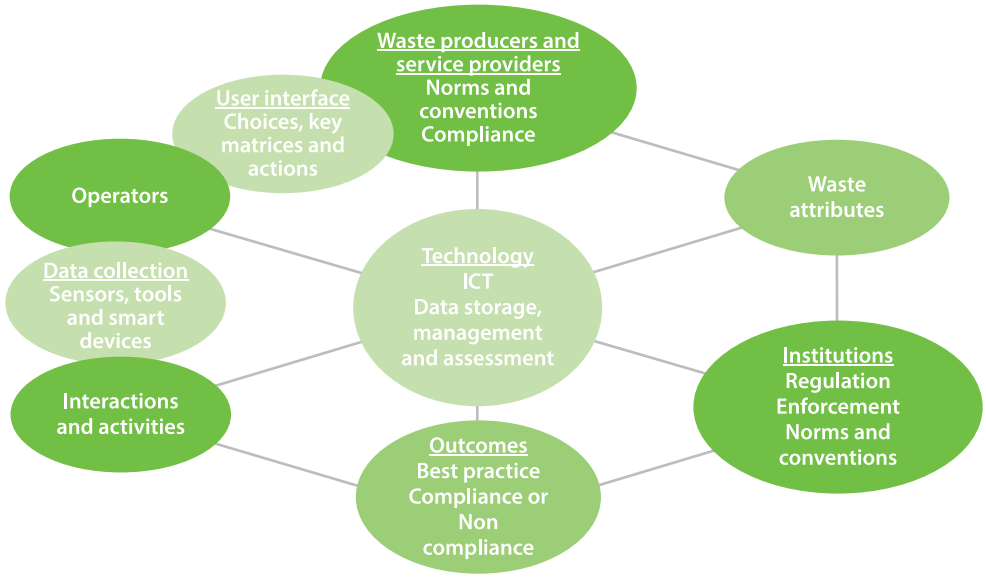
- data management – Information technology (IT), smart waste systems, supply chains,
- vehicle tracking – Geographic information systems (GIS), radio frequency identification (RFID) and sensor technologies,
- waste collection – GIS and RFID (Schindler et al. 2012), waste collection vehicles with sensors to detect loading and unloading, automated weighing and charging,
- waste treatment technologies and
- waste disposal technologies.

Data management should always be regarded as being of the highest priority, since without data there can be no effective control or management of the waste-related activities, nor the necessary links to the supply chain to monitor waste prevention and reduction initiatives.

Smart waste data management systems

Smart interventions are classic economic consolidation strategies that would be adopted by businesses (Porter 1980). Smart waste systems are built from a combination of IT, communications systems, tariff systems and other waste management control and data management systems.

Figure 26: Smart waste system concept



Note: “Waste attributes” here refers to the properties of the waste being managed, which have already been discussed in the context of West Asian countries.

Source: Adapted from Vatn, 2005. Chart by Author

West Asian countries are at an early stage in the development of smart waste systems, as shown in Table 17. As the cost of data management and data storage, integration and networking decrease, these provide economic paybacks through savings in management, monitoring and inspection costs. This can be supported through centralized payment systems that ensure secure payment of, for example, permitting fees or waste tariff collections, as well as actively monitoring and increasing levels of compliance with waste management regulations and permitting systems.

Table 17: Evolving smart waste systems in West Asia

Country	*IT systems	Communications systems	Tariff systems
Bahrain	Yes[1]	Yes[1]	To be introduced in 2019[1]
Iraq	**N/A	**N/A	**N/A
Jordan	Developing[2]	Developing[3]	Developing[3]
Kuwait	Yes[4]	Yes[4]	
Lebanon	Planning[5]	Yes[5]	
Oman			
Palestine	No[6]		Yes[6]
Qatar			
Saudi Arabia	Yes[7]	Yes[7]	Developing[7]
Syria	No[8]		
UAE	Developing[9]	Developing[9]	Yes[9]
Yemen	No[10]		

Notes:
*Most West Asian countries already have waste vehicle tracking systems operated by waste collection contractors. Smart waste systems enable governance, control, monitoring and inspection of these tracking systems by the waste authority in an integrated manner.
**N/A = No information available or provided
Sources: 1. http://www.ukisl.com/wp-content/uploads/2016/08/Performance_Manager_-_Kingdom_of_Bahrain.pdf, https://aet-tracking.com/ as well as https://su.urbaser.com/Bahrain/ and Bahrain country representative. 2. EU EEA (2015). 3. GIZ/SWEEP–Net (2014a). 4. Kuwait Central Statistics Bureau (2017). 5. GIZ/SWEEP–Net (2014b) & Lebanon, Council for Development and Reconstruction (2015). 6. GIZ/SWEEP–Net (2014c). 7. Ramboll (2017) and MOMRA. 8. GIZ/SWEEP–Net (2010a). 9. Abu Dhabi Center of Waste Management (Tadweer). 10. GIZ/SWEEP–Net (2010b).

Source: Compiled by Author

CASE STUDY - Smart and sustainable waste management in Dubai

Rapid growth of industry, trade and urbanization have been the results of a booming, prosperous economy. Dubai has adopted a zero-waste strategy which is supported by a fully integrated and sustainable waste management system designed to meet the demands for a high quality, efficient and effective service.

Smart Sustainability Oasis

The "Smart Sustainability Oasis" is the name of Dubai's innovative recycling centres. Dubai has 13 of these solar-powered self-efficient recycling centres with built in sensors and CCTV cameras directly connected to headquarters. These centres accept waste that is not normally collected at the curbside. This initiative is projected to increase recycling in the Emirate and in turn reduce the quantity of waste going to landfill.

Smart Gate System (Nafith)

Dubai's Smart Gate System (Nafith) is a fully automated entry management system at Dubai municipality landfill sites. Radio frequency identification technology (RFID), automatic number plate recognition (ANPR) and integrated software are utilized to control vehicle entry at sites, gather weight information and make automatic credit deductions. By reducing the time vehicles spend gaining entry, this initiative curbs emissions and increases efficiency. The new system also eliminates the use of paper in entry transactions and reporting and puts an end to human error, as all information is automated.

Fully Automated Entry System at Landfill

RFID Technologies
(Radio Frequency IDentification)

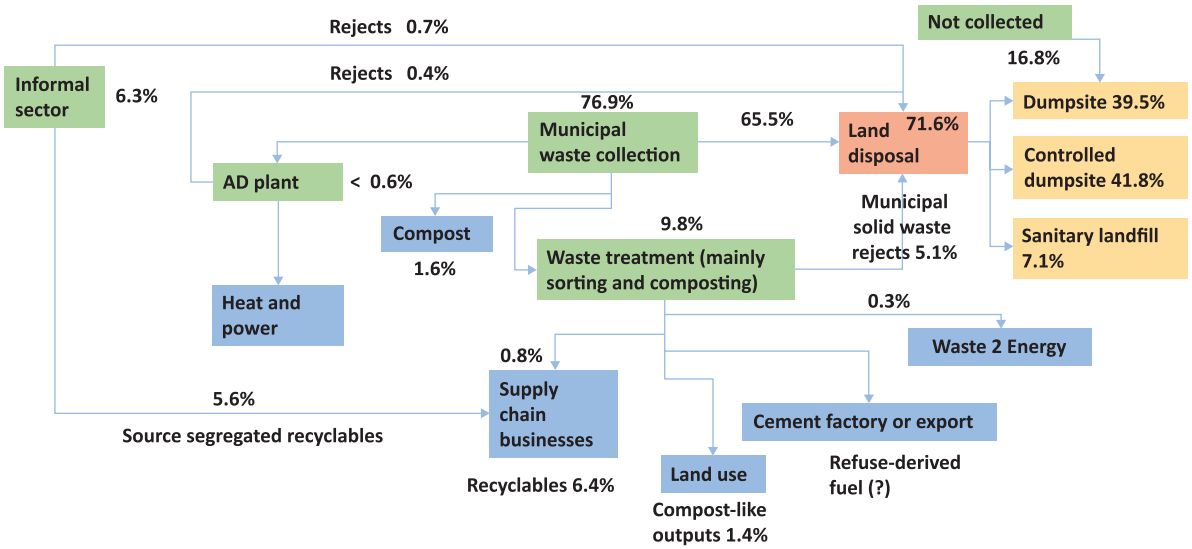
ANPR Cameras
(Automatic Number Plate Recognition)

Smart Software

Technology and implementation

An overview of the estimated capacities[34] of current treatment and disposal technology activities applied in all West Asian countries is shown in Figure 27. The fundamental problem appears to be the current adoption of treatment systems typically based on sorting and composting plants, which, as previously discussed, has been ineffective in diverting waste away from land disposal.

Figure 27: A current overview of West Asian waste activities and capacities



Compiled by Authors, all data is estimated. AD = Anaerobic Digestion

After considering reject waste arising from the waste treatment processes, approximately 88.4% of the total municipal solid waste (includes waste collected by the informal sector) produced by West Asian countries goes to land disposal with an estimated 7.1% going to sanitary landfills, 39.5% to uncontrolled dumpsites and about 41.8% to managed dumpsites. It is not known if there is any treatment currently aimed at producing refuse-derived fuel (RDF).

[34] Capacity tonnages can be estimated by multiplying the percentage by the total regional waste arisings in 2016 (60.4 million tons).

Integrated waste management solutions to divert waste from land disposal include:

- developing source-segregated collection,
- using clean material recycling facilities for sorting source-segregated dry waste,
- using sorting and composting plants,
- applying thermal, non-thermal and bio drying technologies,
- using anaerobic digestion for food waste treatment and
- using waste to energy technologies – pyrolysis, gasification and incineration.

For hazardous wastes, it may be necessary to use thermal, biological, chemical or physical separation processes or stabilization methods to contain contaminants.

Case study – Existing waste treatment practices in the West Bank

The Palestinian Authorities report there are at least 15 Israeli facilities in the occupied West Bank that are engaged in waste treatment. Most of this waste arises from within Israel and from Israeli settlements in the occupied West Bank, including Jerusalem. Of the 15 facilities, six treat hazardous waste such as medical waste, used solvents and oils, used metal batteries, materials from the electronics industry and others. Although treating hazardous waste requires special treatment permits from the Palestinian Authority, this is ignored by the facility operators.

There are at least 98 sites for solid and liquid waste used by the Israeli settlements for disposing their waste. These sites are divided into 34 solid waste disposal sites and 64 sites dedicated to pumping liquid waste. Currently these practices are believed to be detrimental to human health and the environment.

The development of value-added integrated waste management systems in West Asian countries

As discussed in chapter 2, the moisture level of municipal solid waste in West Asian countries is generally high and this is likely to hinder and reduce the efficiency of pre-mechanical sorting processes. The proposed treatment systems focus on dealing with high moisture in the initial treatment of the residual wastes prior to the mechanical and sensor sorting methods. The key challenge here is to create as much value from the recyclables and the residual organics as possible. Source segregation collections can do this but are more expensive than mixed waste collections due to the lower levels of the collection, and with plastic wastes, the waste is much lighter and less compact, leading to an increase in collection distances and costs.

Based on a system proposed in the Master Planning process for Lebanon, the following integrated waste management approach has been designed as a modular system able to scale up from a small district scale of 80,000 tons per year to over 500,000 tons per year, to maximize available value and reduce disposal to around 10% of the original collected volume of the municipal solid waste. The following features should be considered.

1. Smart waste systems based on modern electronic systems that enable the collection of primary data essential to assess performance and progress should be adopted.
2. Iraq, Syria and Yemen need to establish systems that ensure 100% of waste generated by residents and businesses is collected and taken to appropriate facilities.

3. Source-segregated collections should be introduced where these are viable and have the appropriate capability and capacity to enable the recyclables to be segregated and decontaminated (e.g. plastic waste being washed, graded).

4. Waste treatment systems with necessary pretreatment methods need to be designed and developed to ensure maximum value is derived from the wastes to ensure recyclables, oil, chemicals, fuel and energy are returned as economically and environmentally sound resources back into the supply chain.

5. Residual organic wastes dependent on quality should be converted into stabilized carbon compositions in the following order.

    a. For source-segregated organics such as food wastes, green wastes or agricultural wastes, plants, crops and manure:

        i. Composting to produce high-value soil supplements

        ii. Anaerobic digestion to produce methane for power generation or fuel

        iii. Conversion of residual or surplus segregated organic wastes into activated carbon, biochar, oil, biochemicals and fuel gases, making use of fuel gases to generate process energy

    b. For the residuals of contaminated/mixed organics, including municipal solid waste and sludge:

        i. Prescreening to remove bulky wastes or inappropriate waste types (e.g. hazardous waste)

        ii. Shredding and drying the waste to *10% to 15% moisture content

        iii. Mechanically sorting and segregating dried organic, inert solids, glass, metals, paper and plastics

        iv. **Converting low-value paper and plastics to biochar, oil, biochemicals and fuel gases – making use of fuel gases to generate process energy

        v. **Converting mixed organic and fines into biochar, oil and fuel gases; making use of fuel gases to generate process energy

    c. Where there is insufficient capacity to treat organic residual wastes, provide sanitary landfill with disposal methane gas flaring or energy recovery.

Notes:

* At 10% to 15% moisture level the biodegradation process effectively ceases (Barlaz 1990, Rodriquez 2001). This can be achieved at low cost using non-thermal drying technologies.

** As a back-up, modern continuous pyrolysis systems can be run as gasifiers. This overcomes the problem with the quality of the biochar that becomes part of the syngas output. For metalized packaging waste such as crisp and fresh food packets, the wastes can be accumulated after the drying stage, using eddy current separators. The separated metalized packaging waste can be bound, briquetted and run through the continuous pyrolysis unit used in gasification mode (>660°C) to recover the aluminum. The modular continuous pyrolysis/gasification technique could be applied on ships used to collect marine wastes, providing oil for the vessel and revenue from the aluminum recovered.

CASE STUDY - RAK Recycles (Residential source-segregated recycling in the UAE)

This initiative encourages Ras al Khiamah residents to source-separate food waste and recyclables at home and develops an outreach campaign to reach residents. Recycling bags are provided to enable residents to sort and separate food waste and recyclables at home and to think about how much waste they are generating. (Partners: Seven Media, Al Hamra Real Estate, Rak Properties)

Developing social awareness

In most West Asian countries, resources for community awareness campaigns are provided within waste management collection contracts, particularly when promoting new practices for change, such as supermarket, street or curbside recycling schemes. These campaigns can include media coverage (TV and newspapers) using celebrities, as well as community initiatives. Often school children are involved, carrying sustainability messages back to their homes.

Issues such as throwing litter from the car, dropping litter onto the street and fly tipping are now increasingly being recognized as anti-social behaviour in places like Dubai, challenging the norms of the "throwaway society." Emerging global campaigns on plastic waste in the marine environment are now focusing on the estimated 8 million tons a year (Jambeck, et al. 2015) of litter that is dumped or thrown onto our streets and land and are blown or carried into our waterways, streams, rivers, estuaries and oceans globally. Beach cleaning services are normally provided within waste collection contracts in places like Beirut, Abu Dhabi, Dubai and Kuwait, though these services tend to be for beaches that are used by tourists.

Often for awareness campaigns to be effective, the key is getting the message to the right person. In the Emirate of Abu Dhabi, a source-segregated recycling campaign in Al Ain failed. Whilst many of the residents were keen, many households employed housekeepers who were unaware of their employers' aspirations for recycling. Waste becomes a gender issue as often it is women who process the household waste, but there have been no gender-focused studies or reports found regarding waste-related activities in West Asia. However, reports on other gender issues can be found on the United Nations Economic and Social Commission for West Asia (ESCWA) web site.[35]

In villas, it may be easier to find space for segregated waste collection containers, but this is going to be more difficult in an 18-story residential block. Awareness must be supported by creating collection systems that may include providing appropriate (and convenient) locations for collection containers for each type of waste. To support this, authorities need to develop planning guidance for the provision of building and streetscape waste collection containers. The use of vacuum waste systems is becoming more common in tower blocks in the UAE,[36] Qatar[37] and Saudi Arabia.[38] The systems feature mixed waste and recyclable chutes that are accessible to residents on each floor.

Littering becomes a problem in streets with parked cars and constant traffic that restricts efforts by streetcleaners, the use of mechanical sweepers and municipal waste collections. Open-top containers, often overflowing in many West Asian countries, can add to this problem.

[35] See, for example, https://www.unescwa.org/publications/state-gender-justice-arab-region
[36] UAE waste vacuum system case study: http://www.envac.ae/projects/al-jubail-market
[37] Qatar waste vacuum system case study: http://www.envac.ae/projects/heart-of-doha
[38] Saudi Arabia waste vacuum system case study: http://www.envac.ae/projects/jabal-omar-development

It is the government's role to help communities to understand and become aware of the choices they have when they buy food, daily goods and other products. To increase the effectiveness of these awareness campaigns, the campaigns should be linked closely with supply chain and extended producer responsibility initiatives discussed elsewhere in this Regional Outlook.

CASE STUDY - Outreach center and school support - Ras al Khaimah Waste Management Agency

An initiative to develop and build a community environmental awareness communication center for recycling is underway in Ras al Khaimah, UAE. It is aimed at increasing awareness among residents about waste sorting methods as well as the collection and disposal of municipal solid waste. (Partners: Municipality and the Public Service Department)

A waste segregation program and environmentally sound practices are also being introduced in public and private schools. This initiative encourages students and teachers to sort, separate and reduce waste generated at school and to become more environmentally aware. (Partners: Ras al Khaimah Educational Zone, which has 121 schools)

Underground container system demonstration in United Arab Emirates
(The first demonstration of the underground waste collection system in Abu Dhabi)
Source: Nabil Al Mudalal

Chapter 5 References

Barlaz, M., R.K. Ham & D.M. Shaefer (1990). Methane production from municipal refuse: a review of enhancement techniques and microbial dynamics. *CRC Critical Reviews in Environmental Control,* 19(6):557-584, https://doi.org/10.1080/10643389009388384

European Union, European Environment Agency (2015). Development of a waste management information system with integrated possibilities for adjusting it to a specific IT-supported system corresponding to the country's needs: Assessment Report. SEIS Jordan Technical Assistance Action 2 (TA2), Draft 01.

GIZ and SWEEP-Net (2010a). "Country Report on the Solid Waste Management in Syria." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportSyria-En-mai2011.pdf

GIZ and SWEEP-Net (2010b). "Country Report on the Solid Waste Management in Yemen." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportYemen-En-mai2011.pdf

GIZ and SWEEP-Net (2014a). "Country Report on the Solid Waste Management in Jordan." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/sites/default/files/JORDANIE%20RA%20ANG%20WEB.pdf

GIZ and SWEEP-Net (2014b). "Country Report on the Solid Waste Management in Lebanon." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/sites/default/files/LEBANON%20RA%20ANG%20WEB.pdf

GIZ and SWEEP-Net (2014c). "Country Report on the Solid Waste Management in Occupied Palestinian Territories." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/sites/default/files/PALESTINE%20RA%20ANG%20WEB.pdf

Jambeck, J.R., R. Geyer, C. Wilcox, T.R. Siegler, M. Perryman, A. Andrady et al. (2015). Plastic waste inputs from land into the ocean. *Science,* 347(6223), 768-771.

Kuwait, Central Statistical Bureau (2017). Annual Statistical Abstract 2014. Accessed14/10/2017 at https://www.csb.gov.kw/Socan_Statistic_EN.aspx?ID=18

Porter, M.E. (1980). *Competitive Strategy.* New York: Free Press.

Ramboll (2017). Waste Management Assessment for Riyadh, Jeddah, Mecca, Medina and Damman pilot projects. 26 February.

Rodriguez, C., S. Hiligsmanns, M. Ongena, S. Awono & J. Destain (2001). Cellulose enzymatic availability in municipal solid waste, Proceedings Sardinia 01, Eight International Waste Management and Landfill Symposium, 69-77. Available at https://orbi.uliege.be/handle/2268/28392

Schindler, H.R., N. Schmalbein, V. Steltenkamp, J. Cave, B. Wens & A. Anhalt (2012). Smart Trash: Study on RFID tags and the recycling industry. Santa Monica, CA: RAND Corporation, 2012. Available at https://www.rand.org/pubs/technical_reports/TR1283.html

Vatn, A. (2005). Institutions and the Environment. Cheltenham, UK: Edward Elgar Publishing Ltd.

Business and Economic Opportunities in Waste

CHAPTER

Key messages

There are significant business opportunities available to businesses that can utilize waste as raw materials for products or fuel, or for biochemical or energy generation. Further service provider opportunities will arise with the wider regional development of value-added integrated waste management systems.

Outlook

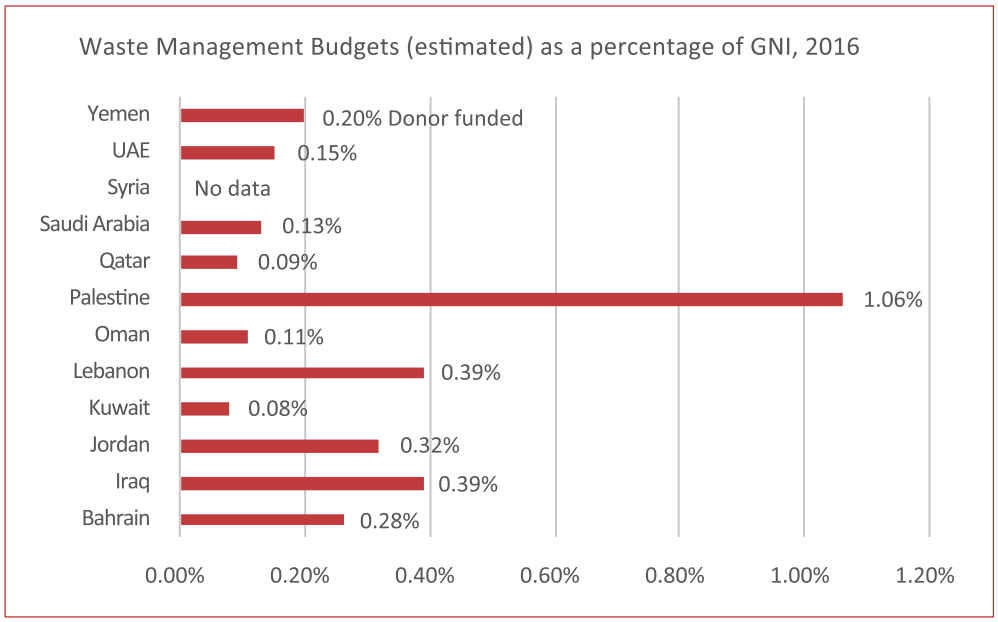
This chapter reviews the costs and benefits of adopting integrated waste management systems and developing the circular economy. Business opportunities are explored in the context of achieving the Sustainable Development Goals and the developing role of the private sector. Procurement and waste management business models are discussed, moving from traditional tenders to the risk-sharing Public Private Partnership models to the shared equity basis for the innovative businesses that use waste as a resource.

Business and economic opportunities can be created from waste management activities in the form of services that are provided for waste collection, treatment and disposal. Businesses opportunities are also created through the returning of waste to the supply chain, either as recyclables or in the form of carbon, biomass, chemicals, fuel or energy.

Understanding costs and benefits

For middle-income countries in West Asia, budget spending has been considerably higher, in the range of 0.32% (Jordan) to 1.06% (Palestine) of GNI, with Yemen at 0.20% based on funding from international donors. In high-income countries estimated spending in 2016 was typically in the range of 0.09% (Bahrain & Qatar) to 0.15% (UAE) of GNI, as shown in Figure 28 below.

Figure 28: Estimated country waste management budgets as a percentage of GNI, 2016



Source: Compiled by Author. GNI data is from World Bank, 2017.

For procuring waste management services, all West Asian governments employ tender systems that are supported by contract and employment law. Some also adopt Public Private Partnership systems which combine equity and debt finance within a structured project, with a risk management arrangement in which both the governmental authority and the private service provider participate. Rapid growth in the GCC countries has seen waste costs rise rapidly. This is because greater volumes of waste are now being generated, requiring the adoption of greater and more enhanced sustainable capacity and capabilities technically.

Not all waste tenders or Public Private Partnerships in the region run smoothly. Up until recently Lebanon has had one of the most advanced collection, treatment and disposal systems anywhere in the West Asia region. However, civil disturbances broke out as a result of the 2015 collapse of the countrywide integrated waste management tender program (Lebanon CDR 2015), a program aimed at improving and extending the facilities dealing with more than half of the country's wastes. An opportunity was lost for the creation of the region's first fully integrated waste management systems. There was a widely reported waste management cost for collection, treatment and disposal of around US$154/ton in Mount Lebanon and Beirut, an amount paid to the existing operator.

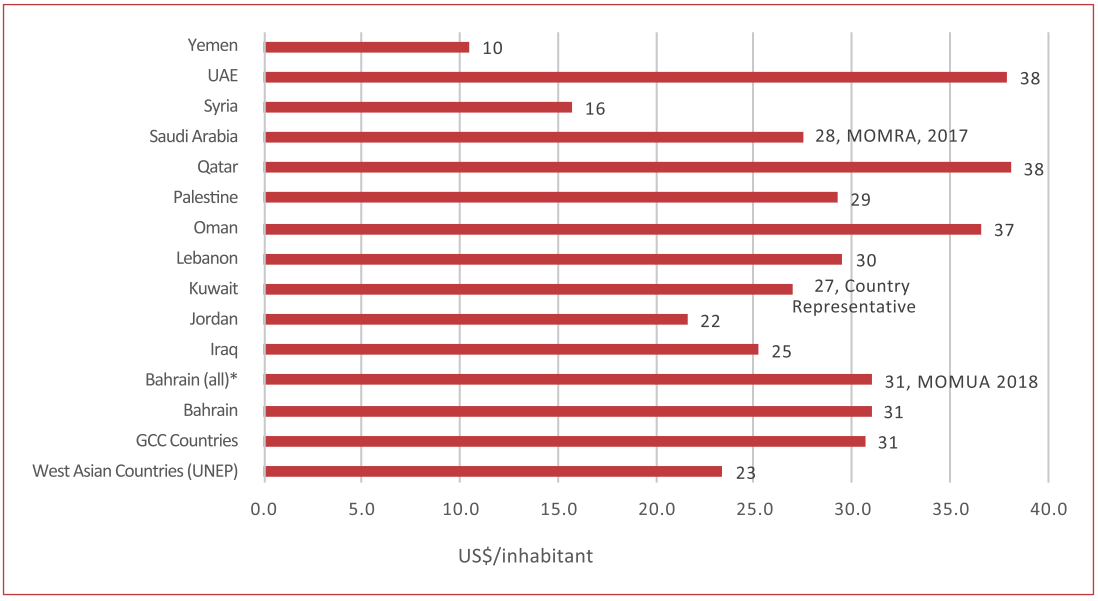
At a regional level, the procurement of waste-to-energy plants has had a checkered history, with only one plant to date of any size, with a feed capacity of 2,500 tons daily. It is understood that the US$1.7 billion Qatari Messaied plant was operating with a municipal solid waste input of about 1,500 tons per day in 2015. It also had a gasification plant capable of handling 500 tons per day.

Waste-to-energy plants proposed for Dubai, Abu Dhabi, Bahrain and Kuwait have to date all fallen by the wayside. They have been cancelled or become stalled as the true costs become known or as government entities block their development by raising objections based on environmental concerns. However, these proposals ultimately bounce back as waste-to-energy developers push hard to get this treatment technology generally accepted in the region (see Table 9, in chapter 2).

In Palestine, in 2012, the target for cost recovery for the state's waste services was about US$23/ton, an amount that covers basic collection and disposal services. However, the actual amount recovered through charges to residents was 33% of the target cost, or US$7.50/ton. For Deir Al Balah Council a 90% cost recovery rate was achieved by charging the local residents through utility bills (GIZ/SWEEP-Net 2014c, 36).

To recover 100% of existing country municipal waste management costs, an annual charge of between US$10 (Yemen) and US$28 (UAE & Qatar) per resident needs to be levied by the authorities. Overall the current average annual cost in West Asia is estimated to be US$23 per resident, and US$31 per GCC country resident, as shown in Figure 29. The Palestinian experience above indicates that US$7.50/ton is an affordable recovery rate in a country beset with significant ongoing historical conflict, refugee and land issues.

Figure 29: Estimated required annual residential tariffs to cover waste management budgets in the West Asia region, 2015

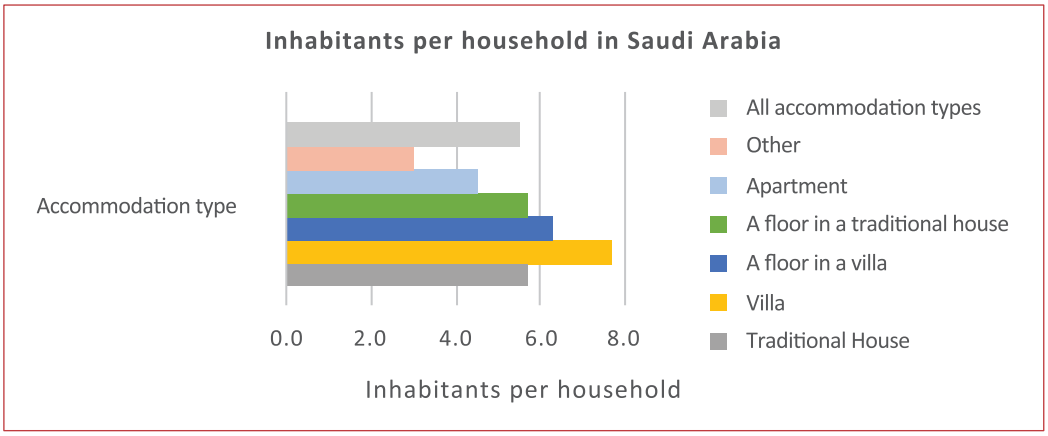


Notes: Data for Kuwait is sourced from the Waste Management Outlook country representative for Kuwait. Data for Saudi Arabia comes from the Ministry of Municipal and Rural Affairs (MOMRA) in 2017. Data for Bahrain is sourced from the Ministry of Works, Municipalities Affairs and Urban Planning (MOMUA) in 2018.

Source: Compiled by Author

Waste or utility tariffs are typically implemented per household by municipal authorities. In Saudi Arabia, raising the household waste tariff to cover 100% of actual costs would increase the average tariff per resident by three to eight times, based on accommodation type, as shown in Figure 30.

Figure 30: Number of inhabitants in Saudi Arabian households, broken down by accommodation type



Source: Saudi Arabia, General Authority for Statistics, 2017

From a policy perspective, a household tariff normally requires legislation detailing what each household must pay. The tariff is usually collected as an annual fee collected by the municipality from the householder or owner. In Lebanon, this is added to the ratable valuation of the property.

Commercial tariffs

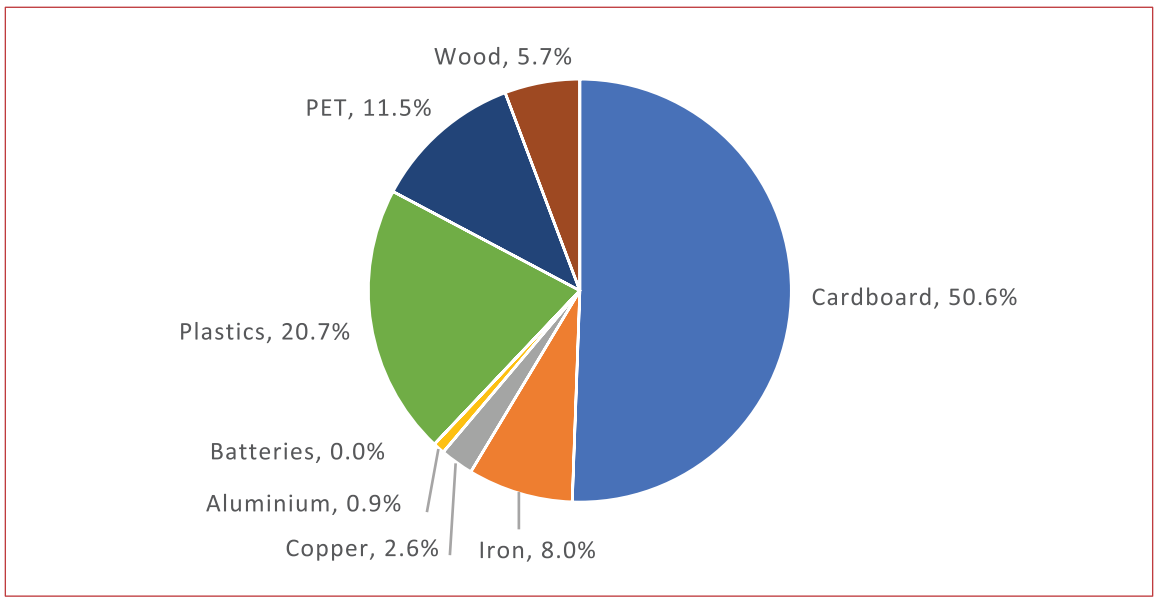
Commercial tariffs are often collected by private waste service providers, who may provide skips and other containers for collection purposes. The rates charged reflect the expenses incurred by the businesses for their services, including recycling and disposal costs. The waste for disposal is taken to official disposal sites or illegal dumpsites. Without strict and effective regulation combined with monitoring and enforcement of these businesses, there is little that many West Asian country authorities can do to ensure that the waste and the recyclables reach appropriate or authorized facilities.

Scavenger income generation

The only studies found on waste collected by scavengers focus on the situation in Lebanon. The composition of waste collected by scavengers in the district of Tyre in Lebanon is shown in Figure 31. The average daily collection for each scavenger is estimated in the range of 56 to 78 kg per day. The income generated by individual scavengers ranges from about US$1.60 to $2.10 per day, resulting in income of about US$45 to $60 per month, which is typically used to supplement the family income.

Scavengers at work near mall (Source: Author)

Figure 31: Types of waste collected by scavengers in the district of Tyre, Lebanon

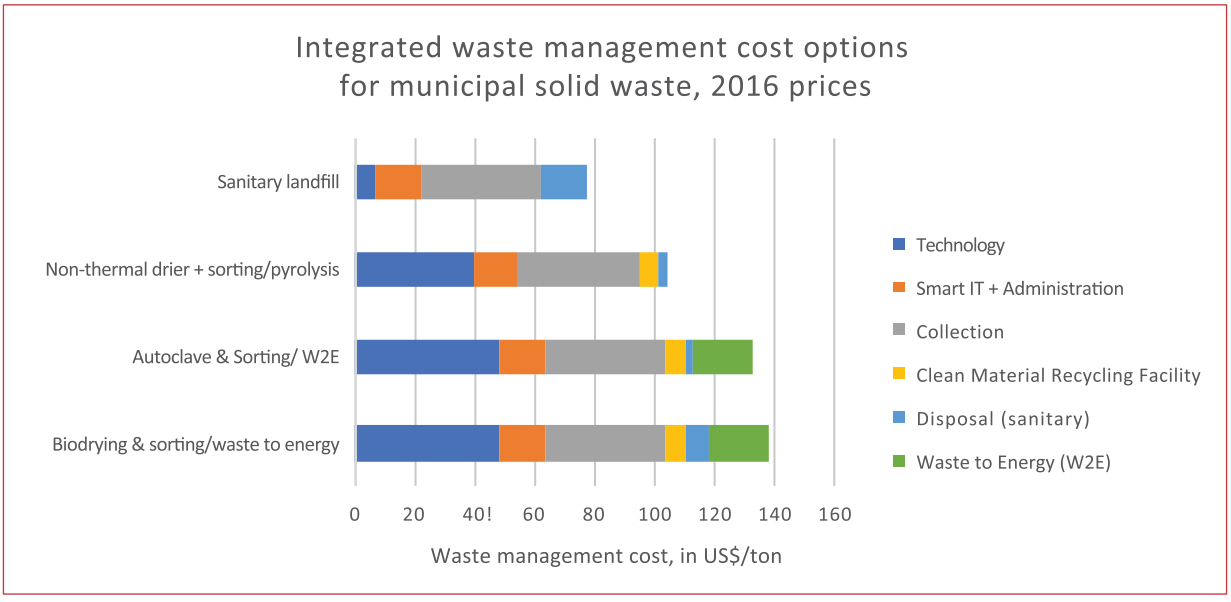


Source: A. Mavropoulos, 2018 (president of International Solid Waste Association [ISWA]), in discussion with the Author.

Cost options for integrated waste management technology

For this analysis, three drier technology combinations were chosen that incorporate bio, thermal (autoclave) and non-thermal drier technologies to overcome the generally high moisture content in the municipal solid waste of many West Asian countries (see Figure 11).

Figure 32: Estimated budget costs of integrated waste management collection, treatment and disposal system combinations



Source: Compiled by Author

The key economic advantage of the non-thermal drier is that it is fast, continuous and, with mechanical treatment, costs about 40% to 60% of bio-drying using mechanical biological treatment (MBT) or high-pressure steam treatment using an autoclave. Additional financing costs for the options shown in Figure 32 may add up to a further US$5 to $40 per ton, depending on technology, market confidence, equity, debt capital and term required.

The simplest and lowest cost option is to put all the waste into a sanitary landfill (see Figure 32). If fully implemented this would, in terms of the Sustainable Development Goals, achieve 100% waste collection and the phasing out of controlled and uncontrolled dumpsites. However, this would not address many of the other sustainable development goals.

The integrated waste management treatment technology solutions with 100% collection and sanitary landfilling will help achieve the primary sustainable development goal targets of

- 100% municipal solid waste collection,
- phasing out dumpsites and
- implementing the 3Rs– "reduce," "reuse" and "recycle."

The non-thermal drier solution provides the best value option of the three and potentially the highest return from the separation of recyclables. Each drier option includes options for source segregation of street collections and the provision of a clean materials recycling facility. Revenue from recycling may offset costs in the range of US$7 to over $40 per ton in income revenues, depending on markets available and the sorting and processing technologies employed. Full integration of, for example, municipal solid waste and agricultural waste, in combination with adequate capacity and favourable market conditions, could turn municipal solid waste treatment processes into revenue generators.

Addressing regional technology capacity deficiencies

Previous planning initiatives to develop waste infrastructure have either not been adopted or have been rejected during the procurement process. In Saudi Arabia, 5 million tons of annual capacity was proposed more than a decade ago using bio drying mechanical biological treatment facilities (Dornier Consulting 2006-2010; Dumble 2012), but to date, no mechanical biological treatment plants have been identified or found in any West Asian country.

Simply upgrading a sorting and composting plant does not necessarily improve performance. In Tripoli, northwestern Lebanon, in 2018, a new plant was closed months after the completion of an extensive refurbishment designed to enhance sorting efficiency and improve the segmentation of valuable plastics through the use of advanced infra-red sensors.[39] The physical properties and processing of municipal solid waste having up to 60% moisture content (Lebanon CDR 2015) provides significant and ongoing problems for process engineers unable to adapt standard mechanical treatment technologies successfully. Such difficulties have been reported for example in the UAE at the sorting and composting plant in Al Ain. International waste companies appear reticent to put forward facility proposals with suitable drying technology capacity, as their tender price will be too high to compete with what are mainly ineffective sorting and composting options.

CASE STUDY - Regional costs and affordability for integrated waste management options

Based on current services, the total of all countries' annual waste management budgets for the entire West Asia region is estimated at US$3.62 billion (see Table 18). Based on current prices, the annual regional cost of integrated waste management with at least 85% landfill diversion would be US$5.92 to $7.86 billion per annum, assuming adoption of the drier options. This would provide an annual integrated waste management service management and operations market of between US$3.3 to $4.7 billion, though the cost of capital could add a further 25% or more dependant on the confidence, leverage, and terms agreed with the debt capital provider.

[39] Sourced from discussions with officials.

In GCC countries, the net annual cost of switching to the non-thermal option is about US$886 million. This will also require adjustments and adaptations to current technology configurations over the next decade to achieve a fully integrated waste management system. The average annual budget cost increase will be about 4% to 5%, and to that should be added annual municipal solid waste growth rates as well as the inflation rate. The current Oman budget may be close to the sanitary landfill estimate, as the Sultanate has been implementing a country-wide initiative on converting controlled dumpsites to sanitary landfills.

Table 18: Optional cost of future waste management technology scenarios

Country	Current waste budgets *	Sanitary landfill	Non-thermal drier + sorting/ pyrolysis	Autoclave & sorting/waste to energy	Bio-drying & sorting/waste to energy
West Asian countries	3,620	4,423	5,920	7,561	7,862
GCC countries	1,640	2,009	2,688	3,434	3,570
Bahrain (all wastes)***	44	140	187	239	249
Bahrain (household waste only)	44	67	89	114	118
Iraq	**887	1,187	1,588	2,029	2,109
Jordan	204	228	305	390	405
Kuwait	109	121	162	207	215
Lebanon	177	181	242	309	321
Oman	162	171	229	293	304
Palestine	133	133	179	228	237
Qatar	98	87	117	149	155
Saudi Arabia	876	1,140	1,526	1,950	2,027
Syria	**289	343	460	587	611
UAE	351	422	565	721	750
Yemen	**289	342	458	585	608

Unit: US$ millions
* Excludes administration costs (assume about 10%)
** May be significantly overestimated due to regional conflicts
*** Includes both household waste and other wastes taken to the Askar dumpsite in Bahrain

Source: Compiled by Author

The Global Waste Management Outlook (UNEP/ISWA 2015) estimates the total cost per ton for sustainable waste management that could potentially be affordable in each country income band, based on a 'rule of thumb' upper limit on affordability of 1% of the GNI per capita and the municipal solid waste generation per capita. As a practical matter, spending 1% of GNI on municipal solid waste management is quite a high figure and some researchers have suggested instead using figures between **0.3% and 0.6% as the upper limit on affordability,** which would extend affordability constraints also to middle income countries and give a range of **0.6% to 1.0% for high income developing countries.** Cases of exceeding the GNI per capita criteria are highlighted in red in Table 19.

Table 19: Assessment of affordability of Integrated waste management options using criteria from UNEP ISWA 2015

Country	1% GNI/ capita	0.6% GNI/ capita	0.3% GNI/ capita	*Current systems (2016; US$/inh)	*Sanitary landfill (US$/inh)	*Integrated waste management drier options (US$/inh)	Waste generation rate, in kg/inh/yr (2016)	Waste generation rate limit
West Asia countries	115.4	69.3	34.6	23.4	28.2	37.8-50.2	364	780 – 290
GCC countries	270.5	162.3	81.2	30.6	37.5	50.2-66.7	484	780
Bahrain (all wastes)	210.9	126.6		31.0	98.3	131.5-174.7	**1,267**	780
Iraq		29.1	14.5	25.2	**31.9**	**42.7-56.7**	411	420
Jordan		24.3	12.2	21.6	24.1	**32.3-42.9**	311	420
Kuwait	348.9	209.3		27.0	29.9	40.0-53.1	385	780
Lebanon		47.0	23.5	29.5	30.1	40.3-**51.5**	388	420
Oman	171.6	103.0		36.6	38.7	51.8-68.7	498	780
Palestine		19.7	9.9	**29.2**	**29.3**	**39.2-52.1**	378	420
Qatar	730.6	438.4		38.1	33.9	45.4-60.3	437	780
Saudi Arabia	208.3	125.0		27.6	35.9	48.0-63.8	462	780
Syria**		13.0	6.5	**15.7**	**18.6**	**24.9-33.1**	240	290
UAE	378.5	227.1		37.9	45.5	60.9-80.9	587	780
Yemen		5.9	3.0	**10.5**	**12.4**	**16.6-22.0**	160	290

Notes: Red indicates value is above the country affordability limits
* Financing costs may add up to 25% to upper limit
** Syria's GNI and GDP are estimated at US$40 billion

Source: Compiled by Author

Bahrain exceeds the GNI per capita criteria because of the inclusion of household waste with construction and demolition waste and other non-hazardous industrial and commercial wastes that are subject to gate fees (Sabbagh et al. 2012). It is clear from earlier analyses that the affordability criteria of 0.3% of GNI is too high for countries such as Yemen that are totally dependent on international assistance for funding of waste management services. Equally, the impacts of conflict and refugees on Iraq, Lebanon, Jordan and Palestine and Syria have or will put waste management budgets under considerable pressure. The affordability criteria for these middle-income countries in the region should not exceed 0.5% of GNI. To achieve the targets for 2030 laid out in the Sustainable Development Goals, all West Asian countries other than the GCC countries will require international funding assistance.

Added value operations

Cleaner production centres can only be developed from additional revenue streams received either from the government, partners, international funders and donors or through trading schemes or adopting business models that provide the necessary resources to support and implement integrated waste management systems. Adding value to recyclables is a vital step that will determine the success of the circular economy. In the UK about US$31 per household was generated through recycling (with a national recycling rate of 45%) within a total waste management cost of US$204/household.[40]

What is missing to make this type of business development possible is the necessary capacity for processes and technologies in the waste management service sector that will result in recyclables of a consistent standard and specification, without contamination. This has become a global issue in developed countries due to the recent banning of recyclable imports in some Southeast and East Asian countries (see chapter 2).

The potential for the development of eco parks (being considered or now in planning in the UAE and Saudi Arabia) that host businesses utilizing plastic, other recyclables and mixed plastic waste streams is compelling, if governments focus on providing the appropriate treatment capacity to generate the recyclables at a supply chain specification that is saleable and uncontaminated. If the waste treatment costs can be overcome, creating a viable profitable business, then market forces will drive these future developments to success.

Organic residuals can be used to generate value through pyrolysis and bio-technologies, with outputs ranging from carbon black to biogas, fuel, biochemicals, absorbents and carbon nanotubes dependent on organic inputs. The value of such outputs ranges from hundreds to thousands of dollars per ton, while novel nano-particles and other such materials are valued at hundreds of thousands of dollars per ton. The waste to raw material innovations, accompanied by producer responsibility, zero waste, circular economy initiatives and supporting policies, are leading a second industrial revolution[41] and a necessary portfolio diversification away from fossil fuels. Organizations such as the Khalifa Fund in Abu Dhabi,UAE and the Kuwait Institute of Science and Research (KISR) are active in supporting start-up businesses that use waste as a resource by employing novel waste technology developments.

Informal sector

The informal sector has a role to play as its members are already in contact with traders and users of recyclables within their country of operation or internationally. Individual informal recyclers rely on this income to supplement other family income. In West Asian countries, the informal sector collects recyclables that are higher quality and three to five times the quantity of recyclables sorted by the authorities.

In the higher middle-income countries of Jordan, Lebanon, Syria and Palestine and the low-income country of Yemen, there is an opportunity to engage with informal groups and develop value-adding opportunities that will create employment in local communities. To enable this, governments need to network and engage with non-governmental organizations to provide startup funding. This may be provided through international crowdfunding platforms and from donor countries in support of local businesses that make use of recyclables as raw materials to manufacture products that can be sold locally, nationally and internationally, driving economic development.

---

[40] See
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/567502/Digest_waste_resource_2016_rev4.pdf
http://www.isonomia.co.uk/?p=5293
https://www.nao.org.uk/wp-content/uploads/2018/03/Financial-sustainabilty-of-local-authorites-2018.pdf
22/04/2018

[41] See the Ellen MacArthur Foundation at https://www.ellenmacarthurfoundation.org/

To ensure the informal sector can provide an adequate supply of recyclables to these new businesses, the government should grant area permits for informal collections based on growing demand for recyclables. By bringing the informal sector into a regulated system, the government will able to improve health and safety aspects in the sector and, through the support provided to local businesses and community startups, give rise to jobs that will create economic and social value in local and regional communities.

Revenues from procurement

Revenues can be raised from profit sharing through Waste Holding Company (WHC) joint venture collaboration on opportunities arising from revenues generated from the value-added outputs of waste reuse, waste recovery and waste recycling activities.

The Bee'ah recycling operation handling 80 tons per day produces, for example, rubber matting for children's playgrounds. This matting is produced at the waste sorting facility in Sharjah, UAE using a cryogenic process to produce a rubber powder from shredded tyres that can easily be molded. Profit sharing takes place in cases of shared investment in concession or service contracts or if there is a public private partnership agreement (as Bee'ah in Sharjah has). In such cases, the municipality is the owner or shares an investment in the land, equipment and facilities.

Cost internalization from extended producer responsibility

Examples of extended producer responsibility policy initiatives being implemented in West Asian countries have not been identified. Extended producer responsibility regulations can be used as economic or market trading instruments to generate revenues from supply chain business wastes. These revenues can be used to fund the development of improved collection systems to support better source segregation of wastes, or for treatment facilities that are effective in increasing the generation of recyclables, fuel or oils, or in manufacturing other products using waste as a resource.

Under extended producer responsibility, the supply chain manufacturer takes physical and financial responsibility for waste at the end of a product's life. Extended producer responsibility is used to encourage manufacturers to reduce waste by using only the quantities of raw materials that are necessary and also reduce the toxicity of materials used in products. This improves the recyclability of the materials used to manufacture the product and reduces the supply chain waste that needs to be collected by municipal authorities. In developed countries such as those in Europe, waste arising from packaging, batteries, end of life vehicles, and electrical and electronic wastes all fall under extended producer responsibility regulations. The post-consumer waste management and treatment costs, including the recycling and recovery of those wastes, is internalized within the product price.

Market fiscal measures

Some consultants (mainly from Europe) recommend the adoption of landfill or carbon-based taxes in West Asian countries. Such taxes are almost impossible to implement without the necessary controls and monitoring on multi-sector waste collection, treatment and disposal operations (as discussed in chapter 5). Market stimulants and disincentives that can be used as revenue-generating economic instruments are introduced to improve the environmental performance of private companies. Grants or tax relief are used to stimulate private investment in innovative green technologies. Disincentives such as the landfill tax are used in the European Union to discourage the landfilling of wastes, which without the tax, would be the lowest-cost waste management option.

Green taxes or bans such as those introduced in the UAE can be used to reduce market demand for items such as single-use plastic bags, many of which can be found polluting the marine environment, or for materials and chemicals such as refrigerants that destroy the atmospheric ozone layer.

Tyres at landfill site. A source of raw materials for new industries? (Source: Author)

Waste tariffs

Waste tariffs can be introduced as an addition to utility costs to householders (see country data tables, Appendix 1) or as a charge to commercial organizations, such as retail companies that use municipal solid waste collection systems in the Middle East. While full cost recovery is likely to be fully achievable for most businesses, only partial engagement is expected from households based on affordability (and willingness to pay), and the degree of engagement by households may vary significantly across West Asian countries.

International funding

All countries in West Asia are classified as developing countries by the World Bank and have been able to access Clean Development Mechanism and, more recently, Green Climate Fund funding under the United Nations Framework Convention on Climate Change. These funding mechanisms can be used to create carbon credits to incentivize donor-funded sanitary landfill with energy recovery, gas flaring or biodegradation processes such as anaerobic digestion that will treat waste by reducing the greenhouse potential of verified methane emissions that are emitted. Several West Asian countries including Jordan, Oman, Saudi Arabia, Syria and the UAE have already accessed output-based financing through the Clean Development Mechanism (see Table 10, page 43). In recent years the Green Climate Fund was launched for larger programs involving sector-based Nationally Appropriate Mitigation Actions (NAMA). As of 29 January 2018, the amount pledged by 43 countries, including nine developing countries, was US$10.3 billion across all sectors, and the UN is urging countries to submit project proposals.[42]

Understanding waste management as a service and as a business

Private sector contractors undertaking projects with a large capital requirement will generally need to use their own capital, borrow money from banks (debt capital), and/or raise money from investors (equity capital). Sometimes the procuring authority will pay for the capital costs of the facility once the design and build stage of the project is completed, subject to a satisfactory commissioning review. Equity may be provided by the company using its own

[42] See https://www.greenclimate.fund/documents/20182/24868/Status_of_Pledges.pdf/eef538d3-2987-4659-8c7c-5566ed6afd19

money or by private sector investors that will negotiate returns for their investment. Many contracts in the region have failed simply due to the private sector not being able to raise capital from private banks. Banks undertake a process known as due diligence, which is a detailed technical and financial review of the proposed project to assure the bank that it will receive the repayments needed to service the loan.

In the Middle East, not-for-profit private businesses such as Bee'ah in Sharjar, UAE bid for contracts, then run the waste management contract in a way that mirrors how the authority might have run the contract if that authority were to manage it themselves. This is a new trend being adopted in the Emirates and other GCC countries to reduce and contain waste management costs. Private sector involvement with regional governments as contracted service providers is shown in Table 20.

Table 20: Private involvement in West Asian municipal solid waste contracts

Country	Contract management	Private sector collection	Private sector disposal	Privates sector treatment	Contract or delivery monitoring
Bahrain	Yes[1]	Yes[1]	No[1]		Developing[1]
Iraq					
Jordan	Yes[2]	No[2]	No[2]		Yes[2]
Kuwait	Yes[3]	Yes[3]			
Lebanon	Yes[4]	Yes[4]	Yes[4]	Yes[4]	Yes[4]
Oman	Yes[5]		Yes[5]		
Palestine		No[6]	No[6]		Yes[6]
Qatar	Yes[7]	Yes[7]	Yes[7]	Yes[7]	Yes[7]
Saudi Arabia	Developing[8]	Yes[8]	Yes[8]		Developing[8]
Syria		No[9]	Developing[9]		Developing[9]
UAE	Yes[10]	Yes[10]	Yes[10]	Yes[10]	Yes[10]
Yemen		No[11]	No[11]		Developing[11]
Notes:	1. Ansari (2012) 2. EU EEA (2015) 3. Fichtner (2014) 4. Lebanon CDR (2015) 5. Harthy (2016) 6. GIZ/SWEEP-Net (2014c) 7. Zafar (2017) 8. Ramboll (2017) 9. GIZ/SWEEP-Net (2010a) 10. United Arab Emirates, Government.ae (2018) "Waste Management," updated 31 October 2018, accessed 23/2/2019 at https://government.ae/en/information-and-services/environment-and-energy/waste-management 11. GIZ/SWEEP-Net (2010b)				

Source: Compiled by Author

To procure services, the public sector authority will release a request for proposals (RFP) which can be acted on by private sector companies known as bidders. The bidders may be subject to a pre-qualification assessment to demonstrate technical competence and economic capability. A proposal must be submitted to the public sector authority in the format specified in the RFP within the timescale provided.

In Kuwait there is an independent public procurement entity that processes the tender to prevent the outcome from being influenced by bias or corruption. Depending on the procurement rules, the lowest priced proposal that achieves at least the minimum required score based on the technical assessment is selected. In the Emirate of Dubai tender bid values and the name of the bidder are published shortly after the opening of bid submissions. After this, there is a period of negotiation in which changes can be made to the technical and commercial proposals of a preferred bidder, subject to agreement by both parties.

Businesses using waste as a resource

Increasingly there are private companies that use waste as a resource. They add value to recyclables by cleaning them, using physical sorting methods employing sensors and treating them mechanically. Alternatively, the waste

may serve as a raw material that substitutes for the whole or partial replacement of virgin raw materials. No criteria or regulations are known to exist in the region setting the conditions or specifications for the return of waste as a recyclable to the supply chain. However, there do exist safety, health, technical and physical specifications for products or goods that only allow the use of virgin raw materials. These specifications could prevent companies from successfully creating products utilizing waste recyclables in the region. Necessary planning, Environmental Impact Assessments (EIA) and permitting conditions may need to be agreed prior to commencing activities.

The circular economy and the principle of extended producer responsibility require that product wastes be recycled and reused in the supply chain, placing pressure on private sector providers to develop new products or modify existing products by using or adding recycled materials. The business risk that results may require the public-sector partner to take on or share part of the financial or environmental risk associated with this venture. The development of eco parks to attract businesses that utilize waste as a resource have been proposed in planning documents in Saudi Arabia and in the Emirate of Abu Dhabi. These are expected to have the potential to generate significant revenue streams for these private companies and public private partnerships.

Business innovation initiatives, organizations, universities and funding providers support this process, including sovereign funds such as the Khalifa Fund in Abu Dhabi, government grants or incentives, university research (e.g. at the American University in Beirut) and technological development institutes such as the Kuwait Institute of Science and Research (KISR) and the Masdar Institute in Abu Dhabi, UAE.

Waste management financing models

Financing models have historically relied on companies to provide their own funds to cover capital and start-up costs, with debt capital used to bridge any gaps. For waste facilities, the financing must consider the appropriate model to fit the waste authority's needs, with most companies having to form joint venture partnerships to raise additional capital (see UNEP/ISWA 2015). Naturally, waste project financing also needs to comply with contract laws.

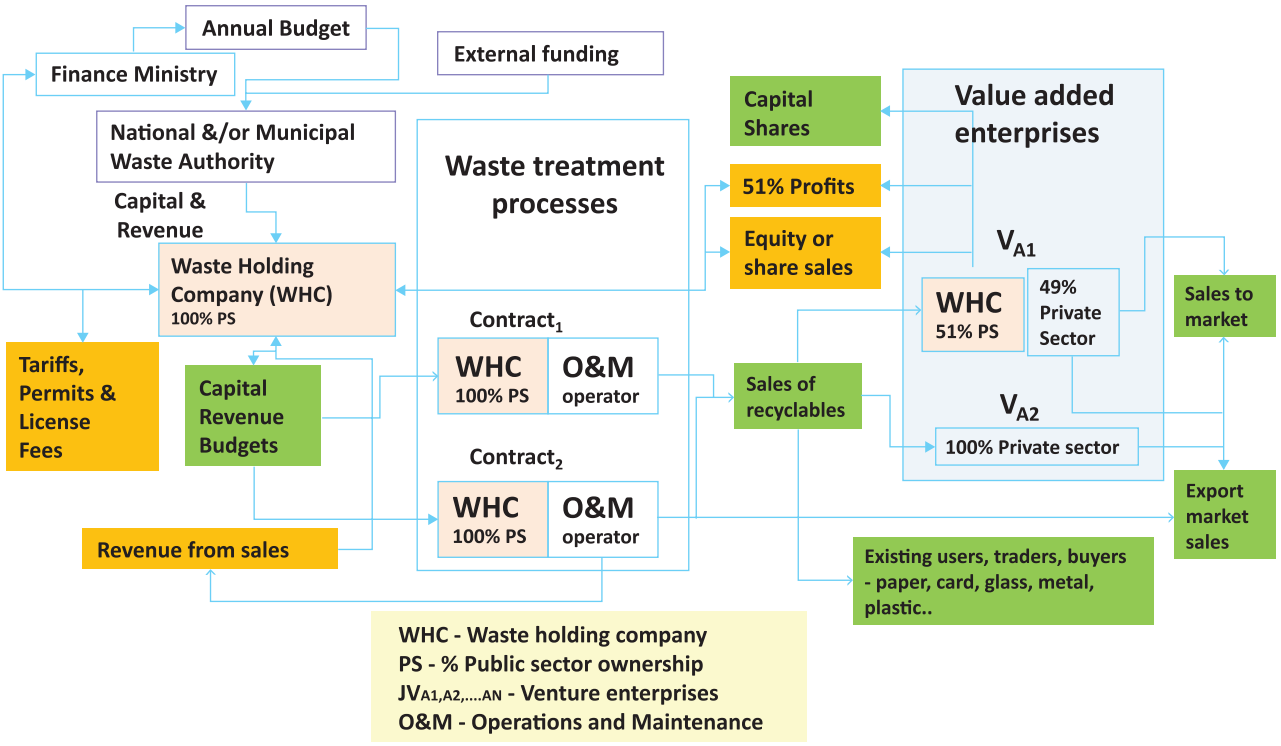
The Bee'ah company operating in the UAE is set up as public sector company (generally referred to as a Waste Holding Company, operating on a not-for-profit basis). This public sector model is currently being adopted throughout the Emirates and in Oman as the preferred form of partnership for procurement.

Two-stage business model for procurement authorities

A national business model that regards waste management as a two-stage process that returns the waste to the supply chain as a resource is shown in Figure 33.

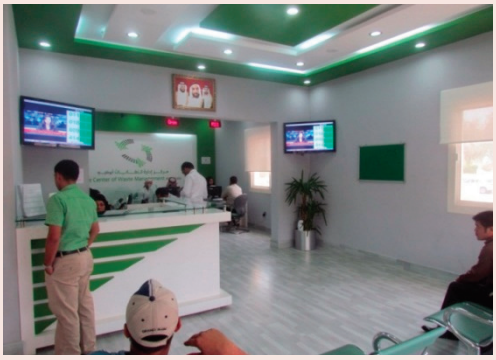
The two stages involve essential treatment processes, which are the traditional collection, sorting and treatment and disposal processes; these processes generate the recyclables that will be used as raw materials by value-adding enterprises producing market goods and products. The public sector Waste Holding Company coordinates waste infrastructure development and national management of waste activities, involving collection, treatment and disposal. This can include active management of supply chain value-added enterprises such as remanufacturing or the creation of businesses that utilize waste as a resource. Such a scheme was considered in 2012 by the Ministry of Municipal and Rural Affairs (MOMRA) of Saudi Arabia.

Figure 33: Business model for a waste holding company



Source: Adapted from Dumble, 2012

CASE STUDY - Smart waste revenue generation systems



In the Emirate of Abu Dhabi, the Nadafa Programme, now operated under the Abu Dhabi Center of Waste Management–Tadweer, achieved a revenue recovery of AED181 million in 11 months during its first year of operation. Excluding pest control costs and administration costs, this represents a first-year recovery of about 35% of the waste management budget in 2011. This figure reached AED340 million in 2017.

Many larger companies have claimed exemptions from the waste tariff as their activities were registered under sectors run by government entities that were exempt from the charges imposed by the waste management entity. However, the legal basis for this exemption has been challenged, and many of these businesses now pay the tariff. The revenues raised come from commercial waste producers, permitting and licensing fees and penalties. The smart waste systems link waste producers and waste collections with a comprehensive waste management database linked to all waste management facilities across the Emirate. The integrated collection system tracks[43] and monitors all vehicles carrying all waste types – industrial, construction and demolition, municipal solid, commercial, agricultural, hazardous, medical and tanker wastes, including septic tank waste, which had been a serious issue prior to the introduction of the programme because of illegal roadside dumping or dumping at convenient off-road locations.

Bahrain and Saudi Arabia appear to be following the example of the Emirate of Abu Dhabi in setting up smart waste systems.

[43] See: http://www.slideshare.net/cubicarttech/catec-tadweer-fleet-tracking-case-study-fleet-tracking-management-tadweer

Deciding on the appropriate financing model

In developing an appropriate financial model, it is important to recognize which solutions are affordable to address the country's needs. This affordability assessment indicates whether a country may need international assistance in funding waste management initiatives. Because Iraq, Jordan, Lebanon and Palestine, Syria and Yemen are affected by conflict and high numbers of refugees, there is a need to raise funding through the United Nations from donor countries to assist in the rebuilding of damaged communities and address the human tragedy and physical damage caused by these conflicts.

Some waste management projects may be funded through the Green Climate Fund (an international funding mechanism within the UN Framework Convention on Climate Change, land the Global Environment Facility (GEF)). These programs require prior assessment and funding source confirmation and, once approved, use a simple tender process to select an appropriate contractor to deliver the project. Green Climate Fund projects are available to all developing countries. A publication on Green Climate Fund processes and on the scaling up of mitigation actions required when transitioning from Clean Development Mechanism projects to Green Climate Fund projects is outlined in Mikolajczyk et al. (2016).

All countries have developed at various levels of implementation waste governance, which establishes key strategic goals and guiding principles. It is necessary that waste governance (discussed in chapter 4) be supported by practical measures on the ground that will effectively bring together stakeholders and resources, creating an environment of confidence for the future development of integrated waste management across the region. This will require:

- setting out responsibilities and partnerships (involving all stakeholder groups),
- introducing proactive policies,
- building sound institutions,
- establishing financial confidence and sustainability and
- utilizing the data revolution—namely, ensuring the availability of reliable and timely data to underpin effective data and resource management as well as decision-making (UNEP/ISWA 2015).

From available information, it seems that most countries in the region have contract and procurement laws in place that set out the procurement responsibilities for government entities. The decision on which financing model to use will depend on the circumstances of the procuring authority. The state or country or funding entity may cover some or all the capital costs of the facility by paying for the facility when it is completed and satisfactorily commissioned or provide a credit or guarantee on necessary payments. Operation and maintenance costs are covered by a combination of funds from the municipal authority and/or the state or, where appropriate, a funding entity.

Often in the Middle East, the structure of the procurement relationship is formalized and decided in the negotiation stages after the tender bids have been selected. This relationship is also discussed in a pre-tender submission meeting and indicated in the Request for Proposal document issued to all bidders. So, the appropriate waste management financing model will be selected or advised by the authority, with the information passed to financing stakeholders (equity and debt) to confirm financial commitments before the formal contract is agreed.

Chapter 6 References

Ansari, S.M. Al (2012). Improving solid waste management in Gulf Co-operation Council states: Developing integrated plans to achieve reduction in greenhouse gases. *Modern Applied Science,* 6(2) (February): 60–68. doi:10.5539/mas.v6n2p60

Azzi, E. (2017). "Waste Management Systems in Lebanon." Degree project, KTH Royal Institute of Technology School of Architecture and the Built Environment, Sweden.

Chmaytelli, M. & A. Hagagy (2018). "Iraq says reconstruction after war on Islamic State to cost $88 billion." Reuters. February 12. Available at https://www.reuters.com/article/us-mideast-crisis-iraq-reconstruction/iraq-says-reconstruction-after-war-on-islamic-state-to-cost-88-billion-idUSKBN1FW0JB

Cointreau, S. (2006). Occupational and Environmental Health Issues of Solid Waste Management: Special Emphasis on Middle- and Lower-Income Countries. Washington, DC: World Bank. Available at http://documents.worldbank.org/curated/en/679351468143072645/Occupational-and-environmental-health-issues-of-solid-waste-management-special-emphasis-on-middle-and-lower-income-countries

Fichtner (2014). Kabd Municipal Solid Waste Project: Waste Composition and Characterization Study, Final report. December.

GIZ and SWEEP-Net (2010a). "Country Report on the Solid Waste Management in Syria." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportSyria-En-mai2011.pdf

GIZ and SWEEP-Net (2010b). "Country Report on the Solid Waste Management in Yemen." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportYemen-En-mai2011.pdf

GIZ and SWEEP-Net (2014a). "Country Report on the Solid Waste Management in Jordan." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/sites/default/files/JORDANIE%20RA%20ANG%20WEB.pdf

GIZ and SWEEP-Net (2014b). "Country Report on the Solid Waste Management in Lebanon." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/sites/default/files/LEBANON%20RA%20ANG%20WEB.pdf

GIZ and SWEEP-Net (2014c). "Country Report on the Solid Waste Management in Occupied Palestinian Territories." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/sites/default/files/PALESTINE%20RA%20ANG%20WEB.pdf

Harthy, M. Al (2016). Transformation of Waste Management in Oman. Presentation to ISWA Energy Recovery Working Group Meeting, West Palm Beach, FL, USA, 25 May 2016,

Hildebrand, H. (2013). The future is nigh: Norwegian waste governance regimes from 1860 to 2010 and an analysis of current waste prevention policies. Master's dissertation, Norwegian University of Life Sciences, Norway. Available at http://www.nb.no/idtjeneste/URN:NBN:no-bibsys_brage_40795

Lebanon, Council for Development and Reconstruction [Lebanon CDR] (2015). Collection and Disposal of Municipal Waste in Lebanon. Part IV: Project Information Memorandum. Authored by El-Khoury, R. & Partners.

Mikolajczyk, S., D. Brescia, H. Galt, F. La Saché, T. Hunzai, S. Greiner, S. Hoch (2016). Linking the Clean Development Mechanism with the Green Climate Fund: Models for scaling up mitigation action. Climate Focus, Perspectives, Aera Group. Available at http://www.climatefocus.com/sites/default/files/Linking%20the%20Clean%20Development%20Mechanism%20with%20the%20Green%20Climate%20Fund%20v3_0.pdf

Nadafa Programme (2015). Data Management Report including funding model. Accessed 20/8/2015 at http://www.ead.ae/wp-content/uploads/2014/03/Waste-PB-Eng.pdf

Ramboll (2017). Waste Management Assessment for Riyadh, Jeddah, Mecca, Medina and Damman pilot projects. 26 February.

Sabbagh, M.K. Al-, C.A. Velis, D.C. Wilson, & C.R. Cheeseman (2012). Resource management performance in Bahrain: A systematic analysis of municipal waste management, secondary material flows and organizational aspects. *Waste Management & Research,* 30(8) 813 –824. DOI: 10.1177/0734242X12441962.

Saudi Arabia, General Authority for Statistics (2017). Housing survey: Housing Bulletin, Semi Annual 2018. Available at https://www.stats.gov.sa/en/911-0

United Nations Environment Programme [UNEP]/International Solid Waste Association [ISWA] (2015). *Global Waste Management Outlook.* Available at http://wedocs.unep.org//handle/20.500.11822/9672

Sustainable Development Goals

CHAPTER

7

Key messages

Key targets and waste-related 2020 and 2030 Sustainable Development Goals can be achieved by most West Asian countries by developing sound governance, planning and implementation measures, as well as by securing the necessary resources to ensure their achievement.

Outlook

This chapter assesses key waste-related targets and their associated Sustainable Development Goals and highlights key actions to support the achievement of 2020 and 2030 Sustainable Development Goals targets.

The Sustainable Development Goals (SDGs) set out interconnecting time-limited targets for countries to achieve a better and more sustainable future by addressing poverty, inequality, the climate, environmental degradation, prosperity, and peace and justice.[44] For waste management, the key goals have been linked with reference to a series of targets described in the Global Waste Management Outlook (UNEP/ISWA 2015).

By 2020 6.3 11.6 12.4

Eliminate uncontrolled dumping and open burning

Regionally, countries are at a very early stage of efforts in this area, with Jordan making efforts to bring dumpsites under authority control but lacking the resources to complete this before the target date of 2020. Iraq and Syria are at a time where their governments are just moving into a post-hostility phase, seeking international support, though Yemen is still in a period of conflict.

Lebanon, with 3.8% of the regional population, has identified over 900 dumpsites used mainly for municipal solid waste and construction and demolition waste. The report risk assesses the likely scale of this issue and estimates that the rehabilitation costs for the most environmentally damaging sites will exceed US$36 (±4) million in total for the top twenty municipal solid waste dumpsites. A further estimate of US$6 million has been made for remediating the top twenty construction and demolition waste dumpsites (MOEL/UNDP 2017). This indicates that regionally, rehabilitation costs are likely to exceed US$1 billion.

As for the GCC countries, Oman is making significant progress in converting its controlled dumpsites into sanitary landfills. Further detailed studies need to be carried out to identify and classify the dumpsites for rehabilitation or remediation. The issue is also being pursued in Saudi Arabia by the General Authority of Meteorology and Environmental Protection (GAMEP). This will bring the environmental management and monitoring of dumpsites (controlled and uncontrolled) within the government's active monitoring regime.

In the Emirate of Abu Dhabi (UAE) in 2009, a study on six major controlled dumpsites was carried out. However, many illegal dumpsites came to be newly identified in 2011 as the global positioning system (GPS) tracking systems fitted to all waste vehicles in the Emirate revealed previously unknown dumping locations. Annually, about 3.5 million tons of unrecorded waste was being dumped illegally, but this was reduced significantly after the introduction of vehicle tracking on all waste collection & transportation vehicles (by CWM Tadweer). In the smaller countries of Kuwait, Bahrain and Qatar and other Emirates in the UAE, it is thought that most if not all disposal sites are controlled, though as in the Abu Dhabi case, without adequate controls on waste vehicles there are also likely to be uncontrolled dumpsites. Full compliance will require all waste transported to uncontrolled or illegal dumpsites to be diverted to controlled sites.

What needs to be done?

Phasing out open dumping by 2020 will be difficult across most countries in the region, with only Oman and the UAE likely to achieve the goal by 2020. This is because dumpsites need to be identified, quantified and classified to enable existing amounts of waste to be diverted and taken to controlled facilities. A regional estimate of land disposal capacity is shown in Figure 27. In all cases this will require the adoption of GPS tracking systems applied to all waste vehicles, as there are likely to be illegal dumpsites in common use. This would take three to five years or more to implement fully in all GCC countries and would need to be supported as a policy objective and strategic plan.

Achieving the 2030 target by countries affected by conflict, including Iraq, Jordan, Palestine, Syria and Yemen, will be difficult without international funding assistance.

[44] See: https://www.un.org/sustainabledevelopment/sustainable-development-goals/

CASE STUDY: Palestine: Rehabilitation of the Yatta dump and construction of sanitary landfill at Minia

To address greenhouse gas emissions and also the problems of open burning, odours, and leachate, which affected local communities, one of the largest uncontrolled dumpsites at Yatta in the West Bank region of Hebron was closed and rehabilitated. It has also been equipped with a gas collection system that generates about 800 cubic meters of biogas daily, thereby generating power while mitigating emissions. This would reduce the amount of emissions to the atmosphere and allow for the proper use of the formed gas, and also put an end to the environmental degradation caused by this random landfill, on the surrounding land environment and on groundwater and surface water and adjacent communities.

A regional sanitary landfill with an annual intake in excess of 800,000 tons has been constructed at Minia in the south of the West Bank. The landfill is made up of 8 cells with a gravel drainage layer and double lining to prevent leakage to groundwater and collect the leachate generated. It is noteworthy that this landfill was recently given an award as the best environmental project in the world within World Bank projects worldwide in countries similar to Palestine. The operation of this landfill has brought about the closure of all dumpsites in the service area, supported by waste recycling initiatives.

By 2020 | 1.2 11.1 11.6

Ensure access for all to adequate, safe and affordable solid waste collection service

Open dumping mainly takes place in communities that lack appropriate collection services that bring collected waste to controlled waste disposal sites or, preferably, to sanitary landfills. The main countries affected by open dumping, and their proportion of municipal solid waste collected, are Iraq (63.9%), Jordan (84.2%), Syria (72.5%) and Yemen (33.9%). Palestine had 91.4% of its municipal solid waste collected in 2016 (see Figure 12 in chapter 2). GCC countries are likely to be mostly compliant, though issues identified above with regard to the 2020 open dumping-related Sustainable Development Goals need to be considered.

Open dumping issues are likely to take many years to implement, but GCC countries are particularly likely to meet the 2020 collection target.

What needs to be done?

The GCC countries—Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the UAE—need to confirm that all residents have access to municipal waste collection services and verify this through monitoring and control systems. Saudi Arabia may need to look closely at rural collection services. Rural collections can cost significantly more than average collections because of population spread and low density. Costs can be lowered somewhat by, for example, providing a single communal collection point in remote villages for basic segregation of dry waste (cardboard, plastic bottles, metal) and mixed waste.

Such a target in the West Asian region could only be fully achieved by 2030 with prioritized international funding, particularly for additional waste collection and or supporting integrated waste management treatment facilities in Iraq, Jordan, Syria, Yemen, Palestine and Lebanon.

Municipal waste collection vehicles at Kuwaiti depot
(Source: Courtesy of National Cleaning Company, Kuwait)

By 2030 | 7 12 4 13

Ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes

The key issue relates to the effective implementation and enforcement of enabling regulations for the Basel, Rotterdam and Stockholm Conventions, as discussed and identified in chapter 4.

Unfortunately, there are no consistent or reliable sources of hazardous waste data for the region. Hazardous waste is handled by the oil and gas entities in the GCC countries. However, non-oil and gas hazardous wastes may be under the control of other entities.

In the Emirate of Abu Dhabi (UAE), global positioning system (GPS) tracking systems are fitted to all waste vehicles so that the movements of vehicles carrying hazardous, industrial and medical wastes are able to be monitored using approved or mandatory transport routes and times. Waste transfer, treatment and disposal facilities can be identified along these routes. A "suitability for purpose" check is also made on waste vehicles as well as competency checks on drivers to ensure loads are delivered securely and safely.

What needs to be done?

This is a complex area that will require a more detailed review of international conventions to identify gaps in the enabling regulations and enforcement measures in each West Asian country.[45]

Ensuring that all hazardous wastes are brought under sound control will require country waste monitoring and/or tracking systems to actively identify and control all waste movements to authorized sites that provide secure, safe and contained transport, storage, treatment and disposal and/or export, particularly for hazardous wastes requiring specialized treatment.

Countries are also unlikely to have adequate treatment and stabilization capacity or lined landfill disposal. These need to be funded mainly by gate fees charged to hazardous waste collection service providers. Without the creation of this revenue stream, the target for 2030 will not be achievable.

If no appropriate treatment or disposal capacity exists in the country, then the waste needs to be exported under Basel, Rotterdam and Stockholm Convention rules to an appropriate and compliant international treatment or disposal facility. Enforcement of these rules is a key issue in attaining full compliance, particularly in Jordan, Lebanon and Palestine.

[45] Governance updates and actions relevant to international conventions are discussed in Chapter 4: Waste Governance.

By 2030

Substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs

Reduce industrial waste generation at source through waste prevention, resource efficiency and greater adoption of clean and environmentally sound technologies and industrial processes

There is an opportunity for West Asian countries in the strategic development of integrated waste management by embracing links within the supply chain to enhance the circular economy. This will create thousands of green jobs and sustain livelihoods by integrating the informal sector into mainstream waste and resource management.

What needs to be done?

Reducing the rate of waste growth is primarily a supply chain issue requiring the introduction of regulations mandating extended producer responsibility. Recycling measures will be improved through, for example, polymer identification and labelling of plastics, and product design focused on the principles described in chapter 1. These principles should be applied to all waste streams, including industrial waste.

The greatest benefit will be through the creation of "green jobs" through strategies to develop a circular economy and through building sustainable livelihoods by integrating the informal sector into mainstream waste and resource management in the poorest cities.

There is an opportunity, particularly in the middle-income countries, to engage with the private sector to build new community enterprises in which recyclable waste is used as raw materials.

By 2025 governments, particularly in middle income countries, should provide support through non-governmental organizations, particularly those with access to crowdfunding platforms, to encourage and fund community start-up enterprises run by informal sector groups to create value from products made from recyclables.

Regional governments should identify and adopt planning guidance and permitting codes that support waste prevention, resource efficiency and the greater adoption of clean, environmentally sound technologies and industrial processes.

One of the biggest private sector providers of employment is the informal sector, which relies on an estimated 250,000 or more informal collectors around the region earning about US$2 per day and also traders, who sell recyclables to markets within and outside of West Asian countries. Regionally, the informal collectors are collectively earning more than US$500,000 per day, with the traders earning additional value-added revenues from sales to internal and external supply chain businesses.

Concerns about the health and safety of informal waste collectors can be addressed when these workers are drawn into established business frameworks and regulations. This may be particularly important in Palestine, which faces significant health issues among children. Recent interviews in Lebanon suggest that the middle-income countries are starting to benefit from community entrepreneurs using waste as a resource.

This Outlook is based on the 3Rs and on circular economy principles and there is general movement by West Asian countries in the adoption of integrated waste management practices. Extended producer responsibility initiatives that internalize the cost of the waste with producers can also provide start-up funding to support new businesses that make use of waste. As time goes on, this will help address waste management costs and budgets across the region. Across the region, there is an estimated potential of US$10 billion or more in added value from new manufacturing industries that will potentially use recyclables as raw materials.

By 2030 | 2 12.3

Halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain

About a third of all food produced becomes waste (UNEP/ISWA 2015). The organic fraction in regional municipal solid waste averages 51.8%, and it is likely that 85% of this is food waste. There is an estimated 25 million tons in the municipal solid waste of all West Asia countries. Halving the food waste would have considerable benefits in increasing the value and quantity of recyclables taken from the municipal solid waste stream, reducing treatment costs and total waste emissions.

What needs to be done?

Halving per capita food waste includes the aspect of prevention. This requires extended producer responsibility regulations with reduction targets for food waste applied by supply chain businesses including restaurants, hotels, food retailers, distributors and food producers. There are currently no extended producer responsibility regulations in place in any West Asian countries.

Implementation of food waste-related extended producer responsibility regulations by 2025 is expected to show a decrease in food waste and moisture content of the collected municipal solid waste by 2030 possibly only up to 20% of the total food waste found within municipal solid waste. The food producers should bear the costs for any actions that will be internalized in food costs. Reducing supply chain food waste should in theory decrease costs to the consumer (as less food is wasted). Even with new legislation and implementation, it is unlikely this target will be achieved by 2030 as it takes many years for best practices to be adopted through the supply chain, from farmers to retailers to restaurants and hotels.

Scavengers operating behind food seller in early morning at Beirut food market (Source: Author)

Food and food packaging wastes in municipal solid waste at disposal site (Source: Photo Courtesy National Cleaning Company, Kuwait)

Food and packaging wastes outside stalls in food market in Beirut (Source: Author)

13

Take urgent action to combat climate change and its impacts

Sound waste management mitigates greenhouse gases that arise, mainly from organic waste. To reduce annual emissions in the region will be challenging in light of 88.4% of municipal solid waste going to landfill. Municipal solid waste in dry tropical and temperate West Asian countries will emit annually about 3% to 5% of the total methane available from the biodegradable carbon (Dumble 2017). Higher levels of methane may be emitted in cooler periods when there are higher levels of precipitation or, as in a sanitary landfill, where the leachate is circulated. If the organic material is treated, then some or all of it can be converted into mainly carbon dioxide (through incineration) or carbon dioxide and methane (through anaerobic digestion) or carbon dioxide, methane and nitrogen oxide (aerobic digestion/composting).

Recyclables including paper, card, aluminium, steel, glass and plastic being returned to the supply chain save the emissions from the energy and fuel that would have been used to extract and process the raw material to the point in the supply chain that the recyclable is used. These savings can range from 0.19 to 0.51 $MgCO_{2eq}$ for each ton of northern European waste (ISWA 2009, 14). This is likely to be in the range of 0.04 to 0.10 $MgCO_{2eq}$ (about 2.0% to 4.9% lifetime emission savings) for West Asia country wastes because of the higher moisture content and the lower recycling rates. The variance within that range is due to paper and cardboard. If each recyclable completes a minimum of five cycles with recycling efficiencies of 88%, the savings will increase by up to 3.4 times, to 0.14 to 0.34 $MgCO_{2eq}$ (about 6.7% to 16.7% lifetime savings). That said, because of the limited circularity in both informal and official collection systems, current savings are likely to be at or below the lower end of this range, with around 86% of these savings due to informal sector activity.

In West Asian countries, the degradable carbon content (DOC) in waste is about 10±2%. This will degrade the carbon equally into carbon dioxide and methane. So, in the dry West Asian climate conditions, about 5% of carbon in municipal solid waste is converted into methane, with a 100-year greenhouse gas potential of 35. So, the methane from degradation of one ton of municipal solid waste will produce a total of 2.04 (±0.41) $MgCO_{2eq}$ when fully degraded, or about 0.10 (±0.02) $MgCO_{2eq}$ per year, in the dry climate disposal conditions. In terms of carbon dioxide produced, for one ton of municipal solid waste, 0.18 (±0.04) $MgCO_2$ is produced after total degradation, and about 0.009 (±0.002) $MgCO_2$ is produced annually in dry climate conditions. If the waste is incinerated, the carbon dioxide will double, as the methane-producing carbon will be converted into carbon dioxide. Additional carbon dioxide will be emitted due to the combustion of non-degradable plastics.

What needs to be done?

There are only three ways to reduce annual emissions from waste:

1. Reduce the quantity of waste below the previous year's quantity through supply chain and consumer waste reduction initiatives,
2. Treat a higher proportion of the biodegradable waste to reduce the greenhouse gas potential of emitted greenhouse gases, or
3. Increase the efficiency of treatment methods used to reduce the greenhouse gas potential of emitted greenhouse gases. This would include increasing recycling, source segregation of food waste for biological treatment and other methods, including thermal waste to energy methods.

The mitigation of lifetime methane emissions from annual municipal solid waste disposals in 2016 has been estimated at 10,900 $GgCO_{2eq}$, or 7.9% of total methane emissions.

Chapter 7 References

Dumble, P. (2017). Regional development and climate change mitigation modelling of municipal solid waste emissions in the Middle East. *Water and Environment Journal,* Vol.31, No.2, p226-234, May. DOI: 10.1111/wej.12236. Available at http://onlinelibrary.wiley.com/doi/10.1111/wej.12236/full

Lebanon, Ministry of the Environment [MOEL] & United Nations Development Programme [UNDP] (2017). Updated Master Plan for the Clearance and Rehabilitation of Uncontrolled Dumps in Lebanon, Volume A. Compiled by Earth Link & Advanced Resources Development [ELARD]. Available at http://www.lb.undp.org/content/lebanon/en/home/library/environment_energy/MASTER-PLAN-FOR-THE-CLOSURE-AND-REHABILITATION.html

United Arab Emirates, Abu Dhabi, Center of Waste Management (2010). Landfill Investigation – Al Dhafra, Al Sila, Al Ruwais, Al Ain, Madinet Zyed and Al Mirfa, Emirate of Abu Dhabi, UAE. Authored by C. Welch, B. Dickson, P. Ford, J. Kjoerstad & D. Cramer, SMEC International Pty.

United Nations Environment Programme [UNEP]/International Solid Waste Association [ISWA] (2015). *Global Waste Management Outlook.* Available at http://wedocs.unep.org//handle/20.500.11822/9672

The Way Forward

CHAPTER

Key messages

A holistic approach involving and supported by key stakeholder groups is vital in developing the necessary capacity and capability for resource-focused integrated waste management systems. Recommendations for each country are presented at a regional, sub-regional and country basis.

Outlook

This final chapter sets out a holistic approach in delivering integrated waste management across the region. Tools are presented to enable delivery of this vision. They accompany a detailed summary of actions to be taken on a country and regional basis for the sound management of hazardous waste and construction and demolition waste and for integrated waste management, partnerships and funding.

The holistic approach

The authorities often view waste management as a budget-driven service where cost savings can be made during economic downturns and increased funding provided during economic growth periods. There is a need to increase budget spending to develop appropriate integrated waste management infrastructure in all West Asian countries. To achieve this, waste management planners must take a truly holistic approach that not only involves the authorities and waste management businesses, but also works with a wide range of stakeholders including:

- communities, to develop sustainable practices in homes and businesses
- the informal sector, to build and develop new opportunities in communities and the supply chain
- business innovators, who bring new technologies that create better or novel raw materials and create businesses that use waste as raw materials
- the business supply chain, to prevent and reduce waste such as food waste
- developers and consortia, including construction businesses, technology companies and the waste management sector, as operators and service providers
- the authorities, to develop and implement Sustainable Development Goal target-driven frameworks for extended producer responsibility, the adoption of the 3Rs as principles and the phasing out of dumpsites
- governments, in liaison with industrial and agricultural waste producers, to fill gaps in legislation addressing hazardous waste and bring regulations in line with international conventions for the sound management of hazardous wastes
- sovereign wealth funds and private investors
- international funders, investors and donors
- the United Nations, the Secretariat of the United Nations Framework Convention on Climate Change, UN Environment Programme, international organizations and non-governmental organizations
- producers adopting extended producer responsibility mechanisms to internalize market costs and enable revenues to be generated from tariffs for sustainable waste management

This approach encompasses not only technical capability and resources but also requires the support of a wide range of players and stakeholders, from both inside West Asian countries and outside the region. Waste management as an issue affects us all.

Because of recent and historical conflicts within the region, there will be a need to marshal internal resources and funding to rebuild damaged infrastructure, housing and communities in West Asian countries torn apart by conflict. A holistic approach is required for resource management, pollution control and environmental management as well as for making the necessary changes to institutional governance and securing stakeholder commitment to support, fund and implement these interventions.[46]

For such a holistic approach to succeed, policy and regulatory control, and the agencies or entities in charge need to work within an integrated holistic framework. While there are often 'separate' environmental control regimes for air, water, land and (solid) waste, the interfaces between them need to be effective. Otherwise, waste and pollution may simply be moved from one receiving medium to another (UNEP/ISWA 2015, 268).

[46] See chapter 1, Figure 2: Analytical frameworks, concepts, tools and planning for the Regional Outlook

Tools to ensure waste is managed in an integrated way

In adopting this holistic approach, the following tools should be adopted to ensure that integrated waste management takes place:

- establish roles and responsibilities for partnerships
- utilize risk assessment frameworks and tools
- utilize modern project, organizational and business management software to manage progress effectively and share risks and lessons learned
- incorporate sustainable principles and Sustainable Development Goal-driven strategic goals
- develop inclusive relationships with all waste generators sharing responsibilities
- build socially and inclusive economic relationships with communities, the informal sector, refugees and other disadvantaged groups to develop sustainable practices, improve the environment and people's lifestyles, and build safe, healthy and vibrant communities
- create partnerships that deliver the services needed to build effective integrated waste management systems, rather than simply procure what is available at the lowest cost, as it often underperforms
- build proactive Institutions and entities that drive policy, legislation and regulation, implementing sustainable waste management strategies with a clear target-driven agenda
- establish institutional frameworks that are supportive of integrated waste management, best practices, infrastructure development and the adoption of best available technologies, and actively coordinate stakeholder relationships
- build financial management systems to support risk- and equity-sharing procurement, and fund future developments that enhance economic, environmental and social benefits
- internalize waste management costs into market prices and reduce supply chain waste by developing extended producer responsibility regulations
- collect the data required for managing waste, and use (or develop) smart tools and models to analyse and project the data to forecast future performance and the likelihood of achieving targets

Creating partnerships to deliver effective services

Key financial partnerships and roles are discussed in chapter 6. The primary role of municipal authorities is to manage municipal waste to protect public health and the environment for those living under their jurisdiction. The authority is responsible for service delivery, or for procuring private sector contractors to deliver these services. The private sector business can be either a local or an international company or a not-for-profit business. With source collection and recyclable market knowledge, the informal sector may also play a role.

Larger businesses or consortia (groups of business that may involve developers, construction companies, operators, technology providers, and equity and debt financiers) involving international companies may provide better access to financing. They may also have substantial experience in operating modern collection, treatment and disposal facilities and through economies of scale they may provide lower-cost services. Municipal authorities may provide the services but lack the access to private funding and investment capital or access to markets for sales of recyclables and refuse-derived fuel (RDF). Public-Private Partnerships can bridge this knowledge and resource gap.

Smaller scale partnerships can be built with local communities, the informal sector and entrepreneurs who use recyclables as a primary raw material for their businesses. Using local knowledge and skills, such initiatives create socially inclusive activities that make the community feel closer and connected while creating new jobs and supporting livelihoods.

Affordability, discussed in chapter 5, is imperative and it will define the type and quality of waste management services that can be operated by municipalities. This often depends on the size, distribution and density of the population served (urban, rural) and there are a wide array of business models that might be employed. It is common in developed countries such as the UK for municipal authorities to form partnerships with neighbouring authorities to achieve economies of scale. This is also the practice of smaller rural authorities in districts in Lebanon, where alliances are often formed even between authorities that have cultural or political differences.

For Public-Private Partnerships, discussed in chapter 6, it is important that the municipality develops the capacity and capability, both technical and managerial, to develop and to procure—that is, to call for tender, assess risks, negotiate, manage, monitor and supervise—contracts. Essential control aspects include using risk-based and performance management tools that enable the municipality and their service providers to respond to future changes or unexpected circumstances. The municipality and the service provider need to have a risk-balanced partnership.

Partnerships that are built on these processes need to be created using the conceptual tools shown in this chapter and chapter 1, procurement processes and the holistic approach that has been discussed throughout this Regional Outlook. For municipalities in the middle-income countries of the region, the international community is an important partner in providing funding for capacity building and improvements in waste management (see UNEP/ISWA 2015 for more details).

Moving Forward - Recommendations at the regional and national levels

Given that this Regional Outlook covers 12 West Asian countries, it is important that recommendations are made not just at the regional and sub-regional levels but also at the country level, covering the key issues identified. These are presented in the following tables that have been compiled by the authors:

- Table 21: Country recommendations for sound hazardous waste management
- Table 22: Recommendations for construction and demolition waste management
- Table 23: Recommendations for integrated waste management
- Table 24: Recommendations for partnerships in and among West Asian countries
- Table 25: Recommendations for accessing funding for West Asian countries

Table 21: Country recommendations for sound hazardous waste management

Country	Hazardous waste management
West Asia region	Develop existing regulations to cover regulatory implementation and enforcement gaps in hazardous waste management covered by the Basel, Rotterdam and Stockholm Conventions
Bahrain	Review hazardous waste treatment and disposal capacity and capability to ensure that hazardous wastes are fully recorded, tracked, managed, contained, stored safely and appropriately treated, stabilized and disposed.
Iraq	Seek international support for unexploded ordnance (UXO) surveys, review and assess the capacity and capability for treatment and disposal of hazardous wastes. New capacity for storage, treatment and disposal may be required for war damaged sites and oil and gas facilities. Review and cover any gaps in legislation to ensure compliance with international treaties.
Jordan	Seek international support for new capacity for the treatment and disposal of hazardous wastes domestically, as currently reliant on the export of hazardous wastes to comply with international treaties.
Kuwait	Continue to develop and implement UN-assisted program to remediate and rehabilitate oil and gatch pits. Review hazardous waste treatment, disposal capacity and capability to ensure that hazardous wastes are fully recorded, transported safely, tracked, managed, contained (e.g. in bunded tanks or stores) and appropriately treated, stabilized and disposed.
Lebanon	Seek international support for new capacity for the treatment and disposal of hazardous wastes domestically, as currently reliant on the export of hazardous wastes to comply with international treaties.
Oman	Continue and expand hazardous waste services to cover hazardous wastes produced outside the oil and gas sector and managed by PDO.
Palestine	Issues with illegal waste treatment requiring more effective enforcement of current regulations need to be addressed. Seek international support for new capacity for the treatment and disposal of hazardous wastes domestically, as currently reliant on the export of hazardous wastes to comply with international treaties.
Qatar	Review hazardous waste treatment and disposal capacity and capability to ensure that hazardous wastes are fully recorded, tracked, managed, contained, stored safely and appropriately treated, stabilized and disposed.
Saudi Arabia	Extend and develop comprehensive environmental control, inspection and monitoring on municipal (MOMRA/GAMEP) and hazardous waste (GAMEP).
Syria	Seek international support for UXO surveys, increasing capacity and capability for treatment and disposal of hazardous wastes domestically, as currently reliant on the export of hazardous wastes to comply with international treaties. Waste collection, treatment and disposal capacity may be required for war-damaged sites and oil and gas facilities.
UAE	Review and identify gaps in provisions of hazardous waste treatment and disposal capacity and capability to ensure that hazardous wastes (especially those outside the oil and gas sector) are fully recorded, tracked, managed, contained, stored safely and appropriately treated, stabilized and disposed to the highest international standards.
Yemen	Seek international support for UXO surveys, increasing capacity and capability for treatment and disposal of hazardous wastes domestically, as currently reliant on export of hazardous wastes to comply with international treaties. Waste collection, treatment and disposal capacity will be required for war damaged-sites and oil and gas facilities.

Table 22: Recommendations for construction and demolition waste management

Country	Construction & demolition wastes
West Asia region	There is an opportunity to employ construction logistics best practices, including supported "Just In Time" systems, which will generate significant savings by reducing losses in construction materials, lessening damage to fittings, plant and equipment and increased efficiency through improvements to planning and logistics.
Bahrain	Develop sustainable building practices that will adopt construction site management plans that include waste management plans in which waste is separated and processed on site and reused or transported to permitted recycling sites. Adopt regulations and municipal ordinances or codes of practice to allow the use of secondary materials obtained from construction waste for suitable civil applications. Adopt best logistics practices to reduce construction site losses of materials delivered.
Iraq	Secure international commitments for reconstruction projects and develop sustainable building practice that will adopt construction site management plans that include waste management plans where waste is processed on site and reused or transported to permitted recycling sites. Adopt regulations and municipal ordinances or codes of practice to allow the use of secondary materials obtained from construction waste for suitable civil applications. Adopt best logistics practices to reduce construction site losses of materials delivered.
Jordan	Develop sustainable building practices that will adopt construction site management plans that include waste management plans in which waste is processed on site and reused or transported to permitted recycling sites. Adopt regulations and municipal ordinances or codes of practice to allow the use of secondary materials obtained from construction waste for suitable civil applications. Adopt best logistics practices to reduce construction site losses of materials delivered.
Kuwait	
Lebanon	
Oman	
Palestine	
Saudi Arabia	
Qatar	Continue to develop sustainable building practice under the Global Sustainability Assessment System (GSAS) adopting construction site management plans that include waste management plans in which waste is processed on site and reused or transported to permitted recycling sites. Adopt regulations and municipal ordinances or codes of practice to allow the use of secondary materials obtained from construction waste for suitable civil applications. Adopt best logistics practices to reduce construction site losses of materials delivered.
Syria	Secure international commitments for reconstruction projects and develop sustainable building practices that will adopt construction site management plans that include waste management plans in which waste is processed on site and reused or transported to permitted recycling sites. Adopt regulations and municipal ordinances or codes of practice to allow the use of secondary materials obtained from construction waste for suitable civil applications. Adopt best logistics practices to reduce construction site losses of materials delivered.
UAE	Continue and expand to other UAE Emirates measures that are being introduced in the Nadafa Programme to better control construction wastes with permitting, tracking, recycling requirements and financial bonds to assure compliance at all stages of the construction process. Extend the Estidama Pearl rating system to all Emirates. Adopt best logistics practices to reduce construction site losses of materials delivered.
Yemen	As the country moves into a post-conflict phase, secure international commitments for reconstruction projects and develop sustainable building practice that will adopt construction site management plans that include waste management plans where waste is processed on site and reused or transported to permitted recycling sites. Adopt regulations and municipal ordinances or codes of practices to allow the use of secondary materials obtained from construction waste for suitable civil applications. Adopt best logistics practices to reduce construction site losses of materials delivered.

Table 23: Recommendations for integrated waste management

Country	Integrated waste management (IWM)-Municipal and commercial wastes
West Asia region	West Asian countries should consider integrated waste management as an economic development opportunity that also brings diversification. Waste is used as a raw material to supply new and growing industries and represents an opportunity in war-torn countries to provide sustainability support to reconstruction and development programs.
Bahrain	It is essential to develop a 100% integrated waste management collection and treatment capacity for municipal solid waste and commercial waste streams. This will prevent the further loss of valuable development land due to the uncontained disposal of commercial and municipal solid waste and due to contamination. There is now a significant need for land within 5km of the Askar disposal site. Considering the recent new oil field announcement that will accelerate future country development and growth in the short, medium and longer terms, it is imperative that the liquid waste pumped into the municipal dumpsite at Askar be stopped immediately to prevent increased and uncontrolled emissions, offensive odours and increased leachate generation and migration.
Iraq	Extend waste collection systems to cover rural areas and achieve 100% national coverage. Continue the development of sanitary landfills started in 2011 and 2012 and the introduction of waste treatment systems to reduce demand on land disposal, though these will have to be effective in dealing with the high moisture levels of the waste. There is an opportunity to engage with informal groups to develop and improve source-segregated recycling, access a wider range of recycling markets and develop value-adding business opportunities that will create employment in local communities.
Jordan	Extend waste collection systems to cover areas not covered and achieve 100% national coverage. Develop and implement plans for sanitary landfills supported by the introduction of waste treatment systems to reduce demand for land disposal, though these will have to be effective in dealing with the high moisture levels of the waste. There is an opportunity to engage with informal groups to develop and improve source-segregated recycling, access a wider range of recycling markets and develop value-adding business opportunities that will create employment in local communities.
Kuwait	Considering recent procurement projects have become stalled or cancelled (as of early 2018), the governing entities have an opportunity to review their municipal solid waste and commercial waste options for integrated waste management treatment systems and look for better value and more advantageous options that will more effectively treat the country's municipal solid waste, which has a high moisture content. Once decided, planning to provide sanitary landfill capacity for the remaining residual waste streams should be considered.
Lebanon	Extend waste collection systems to cover areas not covered and achieve 100% national coverage. Develop and implement plans for sanitary landfills supported by the introduction of waste treatment systems to reduce demand for land disposal, though these will have to be effective in dealing with the waste's high moisture levels. (Note the recent cancellation of contract for a sorting plant upgrade in Tripoli.) There is an opportunity to engage with informal groups to develop and improve source-segregated recycling, access a wider range of recycling markets and develop value-adding business opportunities that will create employment in local communities.
Oman	Review and implement best-value, efficient treatment technologies to reduce demand for disposal at sanitary landfills.

Country	Integrated waste management (IWM)-Municipal and commercial wastes
Palestine	Extend waste collection systems to cover areas not covered and achieve 100% national coverage. Develop and implement plans for sanitary landfills supported by the introduction of waste treatment systems to reduce demand for land disposal. There is an opportunity to engage with informal groups to develop and improve source-segregated recycling, access a wider range of recycling markets and develop value-adding business opportunities that will create employment in local communities.
Qatar	Review, plan and extend current integrated waste management capacity in accordance with the rapid country growth in recent years.
Saudi Arabia	The Kingdom started its journey toward integrated waste management treatment systems with a pilot proposal for the cities of Riyadh, Mecca and Damam, with 5 million tons of mechanical biological treatment capacity proposed and clean material recycling facilities supporting source-segregated collections. This was reviewed in 2012 and is currently being reworked as a waste-to-energy option. There may, however, be better value and more effective treatment options for MOMRA for waste streams that will increase recycling from sorting operations and support the Vision 2030 diversification objectives.
Syria	Extend waste collection systems to cover rural areas and achieve 100% national coverage. Develop and implement plans for sanitary landfills supported by the introduction of waste treatment systems to reduce demand for land disposal, though these will have to be effective in dealing with the high moisture levels of the waste. There is an opportunity to engage with informal groups to develop and improve source-segregated recycling, access a wider range of recycling markets and develop value-adding business opportunities that will create employment in local communities.
UAE	Review collection and treatment technologies and capacities to identify best value and ensure that best-value, efficient collection and treatment technologies can be retrofitted or applied as new capacity.
Yemen	Extend waste collection systems to cover rural areas and achieve 100% national coverage. Develop and implement plans for sanitary landfills supported by the introduction of waste treatment systems to reduce demand for land disposal though these will have to be effective in dealing with the high moisture levels of the waste. There is an opportunity to engage with informal groups to develop and improve source-segregated recycling, access a wider range of recycling markets and develop value-adding business opportunities that will create employment in local communities.

Waste collection and segregated packaging wastes at fish market (Source: Author)

Table 24: Recommendations for partnerships in and among West Asian countries

	Country	Partnerships
	West Asia region	Partnerships having internal and external stakeholders need to be built within stakeholder relationships to enhance market confidence and support financial models that will fund the future development of integrated waste management across the region.
Countries affected by conflict	Iraq	The key elements of funding will involve building or maintaining partnerships with international organizations (UN, World Bank, CEDARE, and others), non-governmental organizations, international donor countries, private investors and developers prepared to provide both equity and debt capital within adopted or new business models, procurement and Public-Private Partnership contracts. Governments will need to review existing commitments to international conventions, decrees, regulations, budgets, codes of practice, technical standards (best available technologies, technology providers) and operating procedures (best practices) to ensure that the legal, technical and financial capability for developing integrated waste management infrastructure and facilities is not hindered. Additional internal funding streams may need to be developed through community and business tariffs and supported with extended producer responsibility measures affecting supply chain companies as they internalize the cost of integrated waste management. Such measures will require policy interventions and regulated intervention strategies, bringing together all key stakeholders. A key opportunity will be to build an ongoing partnership with the informal sector to develop significant new opportunities in the circular economy.
	Jordan	
	Lebanon	
	Palestine	
	Syria	
	Yemen	
Other countries	Bahrain	The GGC countries need to ensure that market confidence is created within the private sector regarding procuring and delivering high-value contracts for waste management treatment facilities, many of which previously have been cancelled or stalled for a variety of reasons in Bahrain, Kuwait and the UAE. GCC countries have access to private investors and developers prepared to provide both equity and debt capital within adopted business models, procurement and Public Private Partnership arrangements. All GCC governments will need to review existing commitments to international conventions, decrees, regulations, liabilities, budgets, codes of practice, technical standards (best available technologies, technology providers) and operating procedures (best practices) such as the review being currently proposed in Saudi Arabia by GAMEP for municipal and hazardous wastes, to ensure that the legal, technical and financial capability for developing integrated waste management infrastructure and facilities is not hindered. Additional internal funding streams may need to be developed through community and business tariffs and supported with extended producer responsibility measures affecting supply chain companies as they internalize the cost of integrated waste management. Such measures will require policy interventions and regulated intervention strategies, bringing together all key stakeholders. A key opportunity in countries such as Saudi Arabia and Kuwait will be to build an ongoing partnership with the informal sector to develop significant new opportunities in the circular economy.
	Kuwait	
	Oman	
	Qatar	
	Saudi Arabia	
	UAE	

Table 25: Recommendations for accessing funding for West Asian countries

	Country	Funding
	West Asia region	Reconstruction efforts in countries directly affected by conflict could lead to requests to the international community for reconstruction funding of more than US$150 billion. Access to US$10 billion through the Green Climate Fund expands options for funding integrated waste management facilities. Opportunities to create new businesses joining the circular economy are worth US$10 billion per annum to the region. The annual budget for a fully operational integrated waste management infrastructure across the region ranges from about US$5 to $7 billion. Efforts need to be made to internalize the cost of waste management development within the supply chain and raise money through utility, household, commercial and industrial waste tariffs, permitting and licensing income.
Countries affected by conflict	Iraq	Funding of integrated waste management will be dependent on securing funding from the international community. Iraq, Syria and Yemen will pursue assistance with infrastructure development in their reconstruction programmes. Funding sought is likely to exceed US$150 billion. This is not so easily obtained, as Iraq has to date only secured US$33 billion in pledges toward a requested US$88 billion at a donor country conference organized early in 2018. There are also opportunities to secure funding for waste management projects through the UNFCCC's Green Climate Fund. For all countries, including those affected by refugees—Jordan, Lebanon and Palestine—there is an opportunity to engage with informal groups and develop value-adding opportunities that will create employment in local communities. To ensure the informal sector can supply businesses, the government should grant area permits for informal collections. By bringing the informal sector into a regulated system, governments will be able to improve health and safety aspects of the work. Governments need to attract inward investment from private investors and entrepreneurs and build confidence in the market, supported by raising revenues through tariffs, added-value recycling initiatives and internalizing integrated waste management development costs through extended producer responsibility initiatives.
	Jordan	
	Lebanon	
	Palestine	
	Syria	
	Yemen	
Other countries	Bahrain	All the GCC countries are well within the affordability criteria to develop fully operational integrated waste management systems and will need to build market confidence among the private sector with regard to procuring and delivering high value contracts for integrated waste management treatment facilities. GCC countries have access to private investors and developers prepared to provide both equity and debt capital within adopted business models, procurement and Public Private Partnership contract arrangements. Additional internal funding streams may need to be developed through community (utility) and business tariffs that will need to be supported with extended producer responsibility measures affecting supply chain companies as they internalize the cost of integrated waste management with the wider costs of sound management of industrial hazardous wastes. Based on the amount of waste generated in 2016, the annual cost of a fully operational integrated waste management system is in the range of US$2.69 billion to $3.57 billion for the GCC countries. Further significant opportunities will be created by the circular economy and through engagement with the informal sector.
	Kuwait	
	Oman	
	Qatar	
	Saudi Arabia	
	UAE	

Initiatives for regional progress

It is important that regional countries in West Asia adopt a holistic approach in coordinating actions to establish and engage with the circular economy through:

- proactive governance supporting the utilization of wastes as resources, removing barriers where appropriate
- the establishment of strategies and plans to achieve Sustainable Development Goals 2030 targets
- supporting and funding municipal authorities' waste procurement programs
- furthering economic development by working with funders, universities and research organizations to identify and achieve circular economy best practices and value-adding technology applications, utilizing modern electronic and smart systems
- encouraging and incentivizing competitive processes to develop country waste treatment systems that are economically viable and cover as wide a range of wastes as practicable
- providing or facilitating financial support through the mechanisms discussed in chapter 6

In support of this, the Global Waste Management Outlook (UNEP/ISWA 2015) sets out a useful framework for designing initiatives that aim to change people's attitudes and behavior and initiate and enable community action. Countries can catalyse and initiate responses that foster sustainable change by:

Enabling	Make it easier; provide the resources
Exemplifying	Lead by example; identify and adopt best practices
Encouraging	Motivate; incentivise; give the right signals
Engaging	Get people involved and taking responsibility

Waste at side of road near fish market close to sea (Source: Author)

Chapter 8 References

United Nations Environment Programme [UNEP]/International Solid Waste Association [ISWA] (2015). *Global Waste Management Outlook.* Available at http://wedocs.unep.org//handle/20.500.11822/9672

International Solid Waste Association [ISWA] (2012). Methane to Markets: Modeling Landfill Biogas Generation and Recovery. Available at https://www.iswa.org/uploads/tx_iswaknowledgebase/ws3.pdf

Acronyms and Abbreviations

AFED	Arab Forum for Environment and Development
CDM	Clean Development Mechanism
CDW	Construction and demolition waste
CEDARE	Centre for Environment and Development for the Arab Region and Europe
DBOFT	Design, build, operate, finance, and transfer
DPSIR	Driver, pressure, state, impact and response
EAD	Environment Agency—Abu Dhabi
EIA	Environmental impact assessment
ESCWA	[United Nations] Economic and Social Commission for Western Asia
EPR	Extended producer responsibility
E-waste	Electrical and electronic waste
GAMEP	General Authority of Meteorology and Environmental Protection, Saudi Arabia
GCC	Gulf Cooperation Council
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
GIS	Geographic information system
GNI	Gross national income
GPS	Global positioning system
GWMO	Global Waste Management Outlook
IEA	International Energy Agency
IETC	International Environmental Technology Centre
INDC	Intended Nationally Determined Contribution
IPCC	International Panel on Climate Change
ISWA	International Solid Waste Association
IWM	Integrated waste management
KISR	Kuwait Institute of Science and Research
MBT	Mechanical biological treatment
MENA	Middle East and North Africa
MENAP	Middle East, North Africa, Afghanistan and Pakistan
MOMRA	Ministry of Municipal and Rural Affairs, Saudi Arabia
MOMUA	Ministry of Works, Municipalities Affairs and Urban Planning, Bahrain
NAMA	Nationally Appropriate Mitigation Actions
NGO	Non-governmental organization
NIP	National implementation plan
OECD	Organisation for Economic Co-operation and Development
PEST	Political, environmental, socio-economic, technological (assessment)
PPP	Public-private partnership

RFID	Radio frequency identification
SDG	Sustainable Development Goal
UAE	United Arab Emirates
UN	United Nations
UNE	United Nations Environment
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
USA	United States of America
UXO	Unexploded ordnance
WHC	Waste holding company
WTE	Waste to energy

Abbreviations and Units

AED	Emirate dirham
CFCs	Chlorofluorocarbons
CO_2	Carbon dioxide
CO_{2eq}	Carbon dioxide equivalent
CH_4	Methane
N_2O	Nitrous oxides
Gg	Gigagram; one thousand tons
Inh	inhabitant
Mg	Megagram; one ton or one tonne (metric)
Kg	kilogram
POPs	Persistent organic pollutants
PCB	Polychlorinated biphenyl
PM	Particulate matter
Ton	All West Asian countries use metric units so “ton” refers to one metric tonne
US$	United States dollar

Useful Definitions

Affordability: Spending up to 1% of GNI on sustainable municipal waste management (UNEP/ISWA 2015, 207-209). Some argue this figure is quite high and suggest using figures between 0.3% and 0.6% as the upper limit on affordability, to provide realistic affordability limits applicable to middle income countries.

Commercial waste: Waste collected from commercial entities such as traders, retailers or office businesses.

Controlled or managed dumpsite: Unlined disposal site that is managed and permitted by the competent authority.

Engineered or sanitary landfill: Lined disposal site that has drainage and leachate collection/treatment and may have landfill gas flaring, or landfill gas recovery with power and or fuel (compressed landfill gas) generation. The landfill is managed and permitted by the competent authority.

Municipal solid waste: This may include all waste collected by the municipality, which might include kerbside collections, street cleaning wastes, street sweeping wastes (mechanical or manual), parks and agricultural waste, animal carcasses, small quantities of construction and demolition wastes, hazardous waste such as cleaning wastes or electronic wastes, commercial and trade wastes, non-hazardous industrial wastes, and in some cases, hazardous and medical wastes.

Uncontrolled dumpsite: Unlined disposal site that is not managed or permitted by the competent authority.

Uncontrolled waste: Waste that is not 'managed' and thus not measured, making it difficult to estimate either the size of the problem or the scale of the associated costs.

Animal waste disposal at dumpsite (Source: Author)

Appendix 1

Country Data Tables

Country data tables are shown for:

1. Bahrain
2. Iraq
3. Jordan
4. Kuwait
5. Lebanon
6. Oman
7. Palestine
8. Qatar
9. Saudi Arabia
10. Syria
11. UAE
12. Yemen

1. Bahrain

Country	Bahrain								Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	1,240,862	1,278,269	1,300,217	1,315,411	1,336,397	1,371,855	1,425,171		1
Urban population	Nos.	1,098,597	1,132,227	1,152,239	1,166,335	1,185,638	1,217,864	1,266,051		2
Refugee population	Nos.	165	199	289	294	311	247	270		3
GNI	US$ billion	23.34	25.39	26.91	28.61	27.72	29.39	30.06		4
GDP	US$ billion	25.71	29.16	30.75	32.90	33.39	31.13	31.86		5
Climate	Dry Tropical									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	60.0	13.0	7.0	4.5	4.0	11.5			13,17,18
MSW Moisture content (Estimated)	% of MSW	47.4							Modelled	15,16
MSW Inert content	% of MSW	13.9							Modelled	15,16
Informal Sector Collection	% of MSW	10.0							Assumed	
Degradable Organic Carbon (DOC)	% of MSW	11.4							Modelled	15,16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (Household)	tons/year	745,522	775,343	793,235	805,164	811,128	817,092	858,417	Report	MOMUA 2017
Waste Generation Rate (Household)	ton/inh/year	0.601	0.607	0.610	0.612	0.607	0.596	0.602		Estimated
MSW Generation (All)	tons/year	1,546,326	1,423,280	1,432,030	1,495,549	1,573,593	1,655,709	1,805,121	Report	MOMUA 2017
Waste Generation Rate (MSW)	ton/inh/year	1.246	1.113	1.101	1.137	1.177	1.207	1.267		Estimated
Waste Collection Coverage*	% of total MSW arisings	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	Report	MOMUA 2017
Commercial waste	tons/year	287,511	247,013	271,246	268,594	No data	No data	329,639	Report	MOMUA 2017
Industrial waste generated	tons/year	87,995	83,567	95,235	84,017	No data	No data	94,862	Report	MOMUA 2017
Agricultural waste generated	tons/year	173,128	117,613	134,000	151,095	No data	No data	168,068	Report	MOMUA 2017
CDW Arisings	tons/year	528,713	534,474	476,163	518,919	No data	No data	708,630	Report	MOMUA 2017
CDW generation rate	tons/year	0.426	0.418	0.366	0.394	No data	No data	0.497		Estimated
E-waste (Household estimates)	tons/year	15,391	15,879	15,890	16,394	17,240	18,297	18,987	Estimated	11,12
E-waste Household Generation	Kg/inh/year	12.40	12.42	12.22	12.46	12.90	13.34	13.32	Estimated	1,11,12
E-waste (Household MSW)	% of MSW	2.06%	2.05%	2.00%	2.04%	2.13%	2.24%	2.21%	Estimated	11,12
Other Indicators										
Hazardous Waste	tons/year	No data	No data	No data	Ho data	No data	4,500	4,603	Report	MOMUA 2017
Medical waste	tons/year	No data	No data	No data	1,367	1,478	1,536	1,079	Report	MOH 2017
	Kg/inh/year	No data	No data	No data	1.039	1.106	1.120	0.757	Report	MOMUA 2017
MSW treatment	% of MSW	0%	0%	0%	0%	0%	0%	0%	Estimated	MOMUA 2017
Sanitary Dumpsites	% of MSW	0%	0%	0%	0%	0%	0%	0%	No CDM projects	MOMUA 2017
Disposal	% of MSW	100%	100%	100%	100%	100%	100%	100%	Estimated	MOMUA 2017
Dumpsite Controlled	% of MSW	100%	100%	100%	100%	100%	100%	100%		
Uncontrolled dumpsites	% of MSW	0%	0%	0%	0%	0%	0%	0%		

Financial	Units									
	Year	2016								
Country	GNI/Capita	21,094								4
Waste Management Budget	US$/inh	31.0							Estimated	1,7,8,9, 18
Affordability upper limit (1%)	US$/inh	211								48
Affordability lower limit (0.6%)	US$/inh	127								48

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source	Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved
IWM development options costs	US$/inh	98.3	131.5	174.7	48				

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	It is believed that uncontrolled dumpsites are no longer in use. Thus requires confirmation		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	The collection systems indicate that all waste users are able to access waste management services		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	The country has regualtory control over hazardous wastes though currently lacks actions to fully implement policy		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	Bahrain is developing a roadmap toward applying the 3R's, though to reduce waste will have to develop this with effective EPR policies and initiatives		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	Bahrain needs to develop effective EPR policies and initiatives affecting food producers, distrbutors, retailers and importers		2030
SDG 13, Take urgent action to combat climate change and its impacts	There are plans for a waste incinerator that if established with reduce methane emissions substantially, though this is held up in planning processes and there may be alternative solutiosn that will work better. Target date to reduce waste emissions needs to be set out in INDC report		No target date

2. Iraq

Country		Iraq							Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	30,762,701	31,727,053	32,776,571	33,883,145	35,006,080	36,115,649	37,202,572		Ministry of Planning
Urban population	Nos.	21,236,723	21,922,759	22,673,193	23,468,144	24,280,567	25,089,903	25,890,014		Ministry of Planning
Refugee population	Nos.	34,655	35,189	98,822	246,298	271,143	277,701	261,882		Ministry of Planning
GNI	US$ billion	140.11	185.55	219.06	233.65	233.55	178.34	170.39		Ministry of Planning
GDP	US$ billion	138.52	185.75	218.00	234.65	234.65	179.64	171.49		Ministry of Planning
Climate	Dry Temperate									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	63.5	4.7	6.3	4.4	5.0	16.1			21
MSW Moisture content (Estimated)	% of MSW	47.1							Estimated	16
MSW Inert content	% of MSW	16.2							Estimated	16
Informal Sector Collection	% of MSW	10.0							Assumed	
Degradable Organic Carbon (DOC)	% of MSW	10.4							Estimated	16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (All)	tons/year	11,377,222	12,986,065	13,798,801	13,308,638	9,928,085	17,360,327	14,891,473		Ministry of Planning
Waste Generation Rate (MSW)	ton/inh/year	0.370	0.409	0.421	0.393	0.284	0.481	0.400		Estimated
Waste Collection Coverage*	% of total MSW arisings	65.7%	62.8%	61.2%	62.4%	62.6%	67.0%	63.9%		Ministry of Planning
Wast collection	tons/year	7,474,835	8,155,249	8,444,866	8,304,590	6,214,981	11,631,419	9,515,651		Ministry of Planning
Industrial Waste Generated	tons/year	11,519	12,016	14,634	12,516	6,832	6,746	9,329		Ministry of Planning
Agricultural Waste Generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
CDW Arisings	tons/year	6,963,470	4,993,278	4,581,517	4,409,304	3,658,861	2,517,981	4,753,766	Report	Ministry of Planning
CDW generation rate	ton/inh/year	0.226	0.157	0.140	0.130	0.105	0.070	0.128		Estimate
E-waste (Household estimates)	tons/year	91,697	94,711	96,260	101,477	108,519	115,754	119,109	Estimated	11
E-waste Household Generation	Kg/inh/year	2.98	2.99	2.94	2.99	3.10	3.21	3.20	Estimated	1,11
E-waste (Household MSW)	% of MSW	0.62%	0.62%	0.61%	0.62%	0.69%	0.78%	0.78%	Estimated	11
Other Indicators										
Medical waste	tons/year	No data	11,075	No data	No data	No data	No data	No data		1,21
	Kg/inh/year	No data	0.349	No data	No data	No data	No data	No data		1,21
MSW treatment	% of MSW	0%	0%	0%	0%	0%	0%	0%	Unknown	
Sanitary Dumpsites	% of MSW	0%	0%	0%	0%	0%	0%	0%	No CDM projects	6
Disposal	% of MSW	100%	100%	100%	100%	100%	100%	100%	Default value	
Dumpsite Controlled	% of MSW	No data	No data	No data	No data	No data	No data	No data	Unknown	
Uncontrolled dumpsites	% of MSW	No data	No data	No data	No data	No data	No data	No data	Unknown	

Financial	Units	
	Year	2016
Country	GNI/Capita	4,580
Waste Management Budget	US$/inh	17.8
Affordability upper limit (1%)	US$/inh	27.5
Affordability lower limit (0.6%)	US$/inh	13.7

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source	Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved
IWM development options costs	US$/inh	31.9	42.7	56.7	48				

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	Iraq moving into post conflict phase - believed many uncontrolled dumpsites remain in use		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	Plans need to be developed to implement 100% collection across the country		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	The country has regulatory control over hazardous wastes though currently lacks actions to fully implement policy		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	Iraq has waste management strategy based on 3RS, but needs to develop policies and regulations to support reduction of waste through EPR measures		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	Iraq needs to develop effective EPR policies and initiatives affecting food producers, distrbutors, retailers and importers		2030
SDG 13, Take urgent action to combat climate change and its impacts	There are no known CDM projects in place to mitigate disposal emissions. Iraq needs to commit to planning (INDC targets) to reduce waste emissions and seek international funding to achieve this.		No target date

3. Jordan

Country		Jordan							Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	7,182,390	7,574,943	7,992,573	8,413,464	8,809,306	9,159,302	9,455,802		1
Urban population	Nos.	5,923,533	6,266,296	6,631,438	7,000,928	7,351,102	7,664,412	7,933,891		2
Refugee population	Nos.	2,450,381	2,430,589	2,337,348	2,712,888	2,771,502	2,808,351	2,860,669		3
GNI	US$ billion	26.21	28.58	30.55	33.26	35.41	37.08	38.35		4
GDP	US$ billion	26.43	28.84	30.94	33.59	35.83	37.52	38.65		5
Climate	Dry Temperate									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	50.0	15.0	16.0	1.5	2.0	15.5			24,25
MSW Moisture content (Estimated)	% of MSW	45.0							Estimated	16
MSW Inert content	% of MSW	11.3							Estimated	16
Informal Sector Collection	% of MSW	10.0							Assumed	
Degradable Organic Carbon (DOC)	% of MSW	11.2							Estimated	16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (All)	tons/year	2,069,000	2,345,072	2,476,516	2,609,150	2,734,184	2,845,140	2,939,582		24,25
Waste Generation Rate (MSW)	ton/inh/year	0.288	0.310	0.310	0.310	0.310	0.311	0.311		1,24,25
Waste Collection Coverage*	% of total MSW arisings	89.9%	83.8%	83.9%	84.0%	84.1%	84.1%	84.2%		24,25
Waste Collection	tons/year	1,859,087	1,964,689	2,077,125	2,190,778	2,298,218	2,393,989	2,475,975		24,25
Industrial waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
Agricultural waste generated	tons/year	No data	No data	4,000,000	No data	No data	No data	No data		25
CDW Arisings	tons/year	No data	No data	2,600,000	No data	No data	No data	No data		25
CDW generation rate	ton/inh/year	No data	No data	0.325	No data	No data	No data	No data		25
E-waste (Household estimates)	tons/year	31,078	32,825	34,074	36,577	39,642	42,614	43,946	Estimated	11
E-waste Household Generation	Kg/inh/year	4.33	4.33	4.26	4.35	4.50	4.65	4.65	Estimated	1,11
E-waste (Household MSW)	% of MSW	1.50%	1.40%	1.38%	1.40%	1.45%	1.50%	1.49%	Estimated	11
Other Indicators										
Hazardous waste (oil)	tons/year	No data	No data	No data	No data	15,000	No data	No data		26
Medical waste	tons/year	No data	No data	4,000	No data	No data	No data	No data		25
	Kg/inh/year	No data	No data	0.500	No data	No data	No data	No data		1,25
MSW treatment	% of MSW	0%	0%	0%	7%	7%	7%	7%	Estimated	26
Disposal	% of MSW	100%	100%	100%	97%	97%	97%	97%	Estimated	Estimated
Sanitary Dumpsites	% of MSW	No data	No data	No data	30%	30%	30%	30%	2 CDM Projects	Estimated, 6
Dumpsite Controlled	% of MSW	No data	No data	No data	20%	20%	20%	20%	Estimated	25,26
Uncontrolled dumpsites	% of MSW	No data	No data	No data	47%	47%	47%	47%	Unknown	25,26

Financial	Units	
	Year	2016
Country	GNI/Capita	4,056
Estimated Waste Management Budget	US$/inh	13.1
Municipality charge	US$/ household	17 to 6
Affordability upper limit (0.6%)	US$/inh	24.3
Affordability lower limit (0.3%)	US$/inh	12.2

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source	Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved
IWM development options costs	US$/inh	24.1	32.3	42.9	48				

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	Jordan is working progressively toward the elimnation of uncontrolled dumpsites. It is unlkely given the situation with high refugee numbers and bringing waste management practices outside of Amman under control. International assistance required.		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	Plans need to be developed to implement 100% collection across the country particulary in rural areas. International assitance required		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	Jordan has regulatory control over hazardous wastes though currently lacks actions to fully implement policy. Inetrnational assitnace will be required.		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	Jordan has started to build the necessary waste management strategy and plans based on 3RS, but need to develop policies and regulations to support reduction of waste through EPR measures, International assistance required.		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	Jordan needs to develop effective EPR policies and initiatives affecting food producers, distrbutors, retailers and importero		2030
SDG 13, Take urgent action to combat climate change and its impacts	There are 2 CDM projects in place to mitigate disposal emissions. Jordan needs to commit to planning (INDC targets) to further reduce waste emissions and seek international funding to achieve this.		No target date

4. Kuwait

Country	Kuwait								Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	2,998,083	3,191,051	3,395,556	3,598,385	3,782,450	3,935,794	4,052,584		1
Urban population	Nos.	2,946,006	3,136,133	3,337,628	3,537,572	3,719,132	3,870,539	3,986,041		2
Refugee population	Nos.	184	335	674	635	614	741	930		3
GNI	US$ billion	123.88	163.21	186.77	187.42	177.38	128.88	141.39		4
GDP	US$ billion	115.42	154.03	174.07	174.16	162.63	114.04	110.87		5
Climate	Dry tropical									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	46.8	19.9	19.8	2.3	3.5	7.7			10,13,31
MSW Moisture content (Estimated)	% of MSW	47.1							Estimated	15,16
MSW Inert content	% of MSW	10.8							Estimated	15,16
Informal Sector Collection	% of MSW	10.0							Assumed	Estimated
Degradable Organic Carbon (DOC)	% of MSW	11.6							Estimated	15,16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (All)	tons/year	1,408,433	1,357,395	1,425,023	1,487,265	1,490,235	1,516,566	1,561,630		Kuwait Central Statistics Bureau
Waste Generation Rate (MSW)	ton/inh/year	0.470	0.425	0.420	0.413	0.394	0.385	0.385		Estimate
Waste Collection Coverage*	% of total MSW arisings	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	Assumed	Estimate
Waste collection	tons/year	1,408,433	1,357,395	1,425,023	1,487,265	1,490,235	1,516,566	1,561,630		Estimate
Commercial waste	tons/year	359,756	333,740	371,356	349,576	341,812	No Data	No Data		Kuwait Central Statistics Bureau
Industrial waste generated	tons/year	No Data	No Data	No Data	No Data	64,456	50,156	77,310		Kuwait Central Statistics Bureau
Agricultural waste generated	tons/year	174,435	142,752	132,267	181,461	265,725	No data	No data		32
CDW Arisings	tons/year	6,570,949	8,541,015	7,704,969	8,862,474	10,979,987	11,185,000	12,805,000		Kuwait Central Statistics Bureau
CDW generation rate	ton/inh/year	2.192	2.677	2.269	2.463	2.903	No data	No data		Estimate
E-waste (Household estimates)	tons/year	49,584	52,853	55,330	59,794	65,058	69,990	71,990	Estimated	11,12
E-waste Household Generation	Kg/inh/year	16.54	16.56	16.29	16.62	17.20	17.78	17.76	Esrimated	1,11,12
E-waste (Household MSW)	% of MSW	3.52%	3.89%	3.88%	4.02%	4.37%	4.62%	4.61%	Estimated	11,12
Other Indicators										
Medical waste	tons/year	1,245	2,592	2,351	2,945	3,514	2,948	3,890		Kuwait Central Statistics Bureau
	Kg/inh/year	0.415	0.812	0.692	0.818	0.929	0.749	0.960		Estimate
MSW treatment	% of MSW	0%	0%	0%	0%	0%	0%	0%	Estimated	
Disposal	% of MSW	100%	100%	100%	100%	100%	100%	100%	Estimated	
Sanitary Dumpsites	% of MSW	0%	0%	0%	0%	0%	0%	0%	No CDM projects	Country representative
Dumpsite Controlled & Uncontrolled	% of MSW	100%	100%	100%	100%	100%	100%	100%	Default value	Unknown
Uncontrolled dumpsites	% of MSW	No Data	No Data	No Data	No Data	No data	No Data	No Data	Unknown	Unknown
Financial	Units									
	Year	2016								
Country	GNI/Capita	34,890								1,4
Estimated Waste Management Budget	US$/inh	28.4							Estimated	1,7,8,9,35
Affordability upper limit (1%)	US$/inh	349								48
Affordability lower limit (0.6%)	US$/inh	209								48

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source	Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved
IWM development options costs	US$/inh	29.9	40.0	53.1	48				

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	Most of Kuwaiti waste goes to uncontrolled unlined disposal sites		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	It is assumed that there access to waste collection systes for 100% of the population. This is subject to confirmation		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	Kuwait has regulatory control over hazardous wastes and has an entity to dispose of the hazardous industrial hazardous waste. It is not clear how medical hazardous waste is treated or disposed. KOC takes charge of oil and gas industry wastes.		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	Kuwait has been in procurementof IWM facilities, which have not been contracted (at time of writing). Also need to develop policies and regulations to support reduction of waste through EPR measures		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	Kuwait needs to develop effective EPR policies and initiatives affecting food producers, distrbutors, retailers and importers		2030
SDG 13, Take urgent action to combat climate change and its impacts	There are no known CDM projects in place to mitigate disposal emissions. Kuwait needs to commit to planning (INDC targets) to redcue waste emissions and seek international funding to achieve this.		No target date

5. Lebanon

Country		Lebanon							Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	4,337,141	4,588,368	4,916,404	5,276,102	5,603,279	5,851,479	6,006,668		1
Urban population	Nos.	3,781,250	4,005,829	4,298,215	4,619,122	4,912,395	5,137,130	5,280,702		2
Refugee population	Nos.	463,436	445,144	575,483	1,303,874	1,606,709	1,529,223	1,476,618		3
GNI	US$ billion	37.50	39.92	43.00	44.06	45.21	46.55	47.06		4
GDP	US$ billion	38.01	40.08	43.21	44.35	45.73	47.08	47.54		5
Climate	Dry Temperate									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	52.5	16.0	11.5	5.5	3.5	11.0			33,34
MSW Moisture content (Estimated)	% of MSW	53.0							Estimated	16
MSW Inert content	% of MSW	13.6							Estimated	16
Informal Sector Collection	% of MSW	12.5							CDR 2015	34
Degradable Organic Carbon (DOC)	% of MSW	9.4							Estimated	16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (All)	tons/year	1,679,112	1,776,980	1,904,676	2,044,730	2,172,272	2,269,273	2,330,256	Estimated	33,34
Waste Generation Rate (MSW)	ton/inh/year	0.387	0.387	0.387	0.388	0.388	0.388	0.388	Estimated	1,33,34
Waste Collection Coverage*	% of total MSW arisings	99.9%	99.9%	99.9%	99.9%	99.9%	99.9%	99.9%	Estimated	33,34
Industrial waste generated	tons/year	No data	No data	No data	112,512	No data	No data	No data		
Agricultural waste generated	tons/year	No data	No data	2,600,000	No data	No data	No data	No data		33
CDW Arisings	tons/year	No data	No data	68,023	73,000	No data	No data	No data		33
CDW generation rate	ton/inh/year	No data	No data	0.014	0.014	No data	No data	No data		1,33
E-waste (Household estimates)	tons/year	39,201	41,533	43,782	47,914	52,671	56,868	58,314	Estimated	11
E-waste Household Generation	Kg/inh/year	9.04	9.05	8.91	9.08	9.40	9.72	9.71	Estimated	1,11
E-waste (Household MSW)	% of MSW	2.33%	2.34%	2.30%	2.34%	2.42%	2.51%	2.50%	Estimated	11
Other Indicators										
Medical waste	tons/year	5,040	No data	No data	No data	No data	No data	No data		34
	Kg/inh/year	1.162	No data	No data	No data	No data	No data	No data		1,34
MSW treatment	% of MSW	45%	45%	47%	48%	48%	48%	49%	Estimated	34
Recycled and composted	% of MSW	15%	15%	16%	16%	16%	16%	16%	Estimated	34
Disposal	% of MSW	85%	85%	84%	84%	84%	84%	84%	Estimated	35
Sanitary Dumpsites	% of MSW	0%	0%	0%	0%	0%	0%	0%	No CDM projects	6,34
Dumpsite Controlled	% of MSW	54%	55%	54%	53%	53%	53%	53%	Estimated	35
Uncontrolled dumpsites	% of MSW	31%	30%	30%	30%	31%	31%	31%	Estimated	35
Financial	Units									
	Year	2016								
Country	GNI/Capita	7,835								1,4
Estimated Waste Management Budget	US$/inh	30.6							Estimated	1,7,8,9,33
Affordability upper limit (1%)	US$/inh	47.0								48
Affordability lower limit (0.6%)	US$/inh	23.5								48

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source	Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved
IWM development options costs	US$/inh	30.1	40.3	53.1	48				

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	Lebanon has surveyed its dumpsites and is planning to implement the recommendations. This will require immediate international assistance to achieve the 2020 target		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	There are a small number of rural locations where waste is collected and dumped locally. Though this is very small proportion. The current master planning should put in place systens to reduce or eliminate this gap.		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	Lebanon has laws in place that require hazardous waste to be exported for treatment and disposal. This is unlikely to have 100% compliance, so policies and measures allowing local treatment and disposal of hazrdous and industrial wastes need to be implemented. International assistance will be required.		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	Lebanon already has in place IWM plans and has adopted the 3R's as a policy and strategic measure. To reduce wastes Lebanon will need to develop EPR policies and regulations. Thus will require international assistance.		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	Lebanon needs to develop effective EPR policies and initiatives affecting food producers, distrbutors, retailers and importers		2030
SDG 13, Take urgent action to combat climate change and its impacts	There are no known CDM projects in place to mitigate disposal emissions. Lebanon needs to commit to detailed planning of INDC targets related to reducing waste emissions and seek GCF funding to facilitate progress.		No target date

6. Oman

Country		Oman							Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	3,041,460	3,237,268	3,464,644	3,711,481	3,960,925	4,199,810	4,424,762		1
Urban population	Nos.	2,285,992	2,450,321	2,640,197	2,846,669	3,056,963	3,260,774	3,455,208		2
Refugee population	Nos.	78	83	138	138	151	245	316		3
GNI	US$ billion	55.06	63.80	72.23	75.70	76.69	67.52	75.93		4
GDP	US$ billion	58.64	67.94	76.69	78.94	81.03	69.83	66.29		5
Climate	Dry tropical									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	30.1	28.8	17.2	3.7	8.3	11.9			36,38
MSW Moisture content (Estimated)	% of MSW	37.9							Estimated	15,16
MSW Inert content	% of MSW	18.4							Estimated	15,16
Informal Sector Collection	% of MSW	10.0							Assumed	
Degradable Organic Carbon (DOC)	% of MSW	11.5							Estimated	15,16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (All)	tons/year	1,490,111	1,591,029	1,707,942	1,834,961	1,963,799	2,087,886	2,205,465		36,38
Waste Generation Rate (MSW)	ton/inh/year	0.490	0.491	0.493	0.494	0.496	0.497	0.498		1,36,38
Waste Collection Coverage*	% of total MSW arisings	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		1,38
Waste collected	tons/year	1,490,111	1,591,029	1,707,942	1,834,961	1,963,799	2,087,886	2,205,465		Estimated
Industrial waste generated	tons/year	No data	No data	86,000	88,823	91,739	94,749	97,860		37
Agricultural waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
CDW Arisings	tons/year	No data	No data	883,714	No data	No data	No data	No data		37
CDW generation rate	ton/inh/year	No data	No data	0.255	No data	No data	No data	No data		1,37
E-waste (Household estimates)	tons/year	40,943	43,643	45,952	50,199	55,453	60,790	63,978	Estimated	11,12
E-waste Household Generation	Kg/inh/year	13.46	13.48	13.26	13.53	14.00	14.47	14.46	Estimated	1,11,12
E-waste (Household MSW)	% of MSW	2.75%	2.74%	2.69%	2.74%	2.82%	2.91%	2.90%	Estimated	11,12
Other Indicators										
Hazardous waste	tons/year	No data	No data	No data	352,725	No data	No data	No data	Excluding slag waste	37
Medical waste	tons/year	769	850	1,023	1,299	1,709	2,462	3,795		38
	Kg/inh/year	0.253	0.263	0.295	0.350	0.431	0.586	0.858		1.37
MSW treatment	% of MSW	0%	0%	0%	0%	0%	0%	0%	No MSW treatment	
Disposal	% of MSW	100%	100%	100%	100%	100%	100%	100%		38
Sanitary Dumpsites	% of MSW	No data	No data	No data	No data	No data	No data	100%	1 CDM project	6,38
Dumpsite Controlled	% of MSW	No Data	No Data	No Data	No Data	No Data	No Data	0%	317 dumpsites	38
Uncontrolled dumpsites	% of MSW	No Data	No Data	No Data	No Data	No Data	No Data	0%		38

Financial	Units	
	Year	2016
Country	GNI/Capita	17,161
Estimated Waste Management Budget	US$/inh	19.2
Affordability upper limit (1%)	US$/inh	172
Affordability lower limit (0.6%)	US$/inh	103

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source	Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved
IWM development options costs	US$/inh	38.7	51.8	68.7	48				

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	It is understood that Oman has implemented a plan to replace all dumpsites with modern sanitary landfills by 2016. This is subject to confirmation.		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	It is assumed that all Omani residents will have access to wate collection services. This is subject to confirmation		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	In 2011/12 the oil and gas entity PDO put out a tender for a country wide coverage of hazardous waste management services. It is not ckear how waset streams ouside the oil and gas sector might be dealt with, so the authorities need to clarify the scope and range of these services and fill any gaps in terms of policy, regulation and infrastructure planning.		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	It is understood that Oman is developing strategies for implementation of IWM and the 3R's. To reduce waste Oman will need to develop policies and regulations for EPR		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	Oman needs to develop effective EPR policies and initiatives affecting food producers, distrbutors, retailers and importers		2030
SDG 13, Take urgent action to combat climate change and its impacts	There are no known CDM projects in place to mitigate disposal emissions. Oman needs to commit to detailed planning of INDC targets related to reducing waste emissions and seek GCF funding to facilitate progress.		No target date

7. Palestine

Country	Palestine								Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	4,050,000	4,168,860	4,293,313	4,420,549	4,550,368	4,682,467	4,817,000		SPEQA
Urban population	Nos.	2,984,850	3,084,956	3,177,051	3,271,206	3,262,365	3,460,343	3,564,580		SPEQA
Refugee population (World Bank)	Nos.	2,015,855	1,895,043	1,944,544	1,994,493	2,051,098	2,104,001	2,158,274		3
Refugee	Nos.	376,650	387,703	399,278	411,111	423,184	435,469	447,981		SPEQA
GNI	US$ billion	9.51		8.38	8.77		8.54	8.54		SPEQA
GDP	US$ billion	8.91		6.64	7.48		7.72	7.72		SPEQA
Climate	Dry Temperate									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	50.0	12.5	14.6	2.4	1.9	18.6			SPEQA
MSW Moisture content (Estimated)	% of MSW	50-60%							Estimated	SPEQA
MSW Inert content	% of MSW	11.0							Estimated	16
Informal Sector Collection	% of MSW	10.0								Assumed
Degradable Organic Carbon (DOC)	% of MSW	11.0							Estimated	16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (All)	tons/year	No data	No data	1,451,140	No data	No data	No data	1,290,185	From WGR	Estimated
Waste Generation Rate (MSW)	ton/inh/year	No data	No data	0.338	No data	No data	No data	0.268		SPEQA
Waste Collection Coverage*	% of total MSW arisings	No data	No data	91.4%	No data	No data	No data	95.0%		SPEQA
Waste Collection	tons/year	No data	No data	1,325,638	No data	No data	No data	1,225,676	From MSW generation	Estimated
Industrial waste generated	tons/year	No data	131,344	No data	No data	No data	No data	No data		SPEQA
Agricultural waste generated	tons/year	No data	No data	440,000	No data	No data	No data	No data		SPEQA
CDW Arisings	tons/year	No data	No data	883,714	No data	208,996	No data	No data		SPEQA
CDW generation rate	ton/inh/year	No data	No data	0.218	No data	0.046	No data	No data		Estimated
E-waste (Household estimates)	tons/year	10,994	11,345	11,502	12,085	12,884	13,716	14,102	Estimated	11
E-waste Household Generation	Kg/inh/year	2.88	2.89	2.84	2.90	3.00	3.10	3.10	Estimated	1,11
E-waste (Household MSW)	% of MSW	0.77%	0.77%	0.76%	0.77%	0.80%	0.82%	0.82%	Estimated	11
Other Indicators										
Medical waste	tons/year	No data	3,226	No data	No data	No data	No data	No data		40
	Kg/inh/year	No data	0.821	No data	No data	No data	No data	No data		Estimated
MSW treatment	% of MSW	No data	No data	No data	No data	No data	No data	No data	Estimated	40
Recycling and composting	% of MSW	No data	No data	1.0%	No data	No data	No data	4.0%		SPEQA
Disposal	% of MSW	No data	No data	99.0%	No data	No data	No data	96.0%		SPEQA
Sanitary Landfills	% of MSW	No data	No data	No data	No data	No data	No data	77%	3 Sanitary sites	SPEQA
Dumpsite Controlled & Uncontrolled	% of MSW	No data	No data	No data	No data	No data	No data	23%		SPEQA
Uncontrolled dumpsites	% of MSW	No data	No data	No data	No data	No data	No data	23%		SPEQA

Financial	Units	
	Year	2016
Country	GNI/Capita	1,773
Waste Management Budget	US$/inh	18.8
Municipal fees	US$/inh	1.0
Affordability upper limit (0.6%)	US$/inh	10.6
Affordability lower limit (0.3%)	US$/inh	5.3

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source
IWM development options costs	US$/inh	29.3	39.2	52.1	48

Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	All random landfills have been closed in the north and south of the West Bank. There are still random landfills in the middle area, due to the occupation's closure of the center's Sanitary landfill, although the plan is still underway to complete the closure of all random landfills.	Decision of the Council of Ministers to adopt a solid waste management system	2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	The national strategy for solid waste management in Palestine 2017-2020. The service coverage of the quiet areas of solid waste collection is 95%, the target will be 100% by the year 2022	Decision of the Council of Ministers to adopt a system	2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	Preparation of the national report on the status of hazardous wastes in Palestine. Preparation of the list of hazardous wastes in Palestine. Review the previously prepared hazardous waste management plan, and work to identify and adjust gaps and commensurate with the Gap report.	The decision of the Council of Ministers on the dangerous waste trade regime.	2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	Palestine needs to develop IWM polices, regulations and plans. To reduce wastes Lebanon will need to develop EPR policies and regulations. Thus will require international assistance.	Hazardous lists were prepared and adopted	2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	The national strategy for solid waste management contains many interventions and projects that feed into the concept of recycling and reuse, but currently the proportion of recycled materials does not reach 1%, with target in 2022 of up to 30%.	National strategy for solid waste management in Palestine 2017-2020	2030
SDG 13, Take urgent action to combat climate change and its impacts	The report of the first national communication on climate change was prepared.The nationally Determined contributions report was prepared and formally adopted by the Council of Ministers.A range of climate change adaptation projects are underway	Develop national policy, strategy and interventions to address this issue	No target date

8. Qatar

Country		Qatar							Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	1,779,676	1,952,054	2,109,568	2,250,473	2,374,419	2,481,539	2,569,804		1
Urban population	Nos.	1,755,739	1,928,864	2,087,333	2,229,341	2,354,450	2,462,779	2,552,252		2
Refugee population	Nos.	51	80	80	130	133	120	176		3
GNI	US$ billion	112.18	154.50	174.71	188.36	196.92	161.08	187.76		4
GDP	US$ billion	125.12	167.78	186.83	198.73	206.22	164.64	152.47		5
Climate	Dry tropical									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	57.0	11.0	14.0	4.0	9.0	5.0			42
MSW Moisture content (Estimated)	% of MSW	44.0							Estimated	15,16
MSW Inert content	% of MSW	16.0							Estimated	15,16
Informal Sector Collection	% of MSW	10.0							Assumed	
Degradable Organic Carbon (DOC)	% of MSW	10.7							Estimated	15,16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (All)	tons/year	846,630	815,302	871,608	930,663	1,048,048	1,095,866	1,123,652		41
Waste Generation Rate (MSW)	ton/inh/year	0.476	0.418	0.413	0.414	0.441	0.442	0.437		1.41
Waste Collection Coverage*	% of total MSW arisings	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	Assumed	42
Industrial waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
Agricultural waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
CDW Arisings	tons/year	4,276,414	7,056,350	9,354,487	9,706,885	9,569,784	9,203,462	No data		41
CDW generation rate	ton/inh/year	2.403	3.615	4.434	4.313	4.030	3.709	No data		1,41
E-waste (Household estimates)	tons/year	27,893	30,640	32,576	35,439	38,703	41,820	43,261		11,12
E-waste Household Generation	Kg/inh/year	15.67	15.70	15.44	15.75	16.30	16.85	16.83		1,11,12
E-waste (Household MSW)	% of MSW	3.29%	3.76%	3.74%	3.81%	3.69%	3.82%	3.85%		11,12
Other Indicators										
Medical waste	tons/year	No data	No data	No data	No data	No data	No data	No data		
	Kg/inh/year	No data	No data	No data	No data	No data	No data	No data		
MSW treatment	% of MSW	0%	0%	29%	27%	25%	23%	23%	1400 ton/day W2E	42
Recycling and composting	% of MSW	No data	No data	4%	3%	3%	3%	3%	Estimates	42
Incineration	% of MSW	No data	No data	26%	24%	22%	21%	20%	Estimates	42
Disposal	% of MSW	100%	100%	71%	73%	75%	77%	77%	Estimates	42
Sanitary Dumpsites	% of MSW	0%	0%	0%	0%	0%	0%	0%	No CDM projects	6,42
Dumpsite Controlled	% of MSW	100%	100%	71%	73%	75%	77%	77%	Estimates	42
Uncontrolled dumpsites	% of MSW	0%	0%	0%	0%	0%	0%	0%		42

Financial	Units	
	Year	2016
Country	GNI/Capita	73,062
Estimated Waste Management Budget	US$/inh	67.1
Affordability upper limit (1%)	US$/inh	731
Affordability lower limit (0.6%)	US$/inh	438

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source	Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved
IWM development options costs	US$/inh	33.9	45.4	60.3	48				

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	It appears that Qatar has already eliminated the use of uncontrolled dumpsites. This requires official confirmation		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	It is assumed that waste collection services sevice all communities in Qatar (Subject to confirmation)		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	Qatar has a hazardous waste treatment facility near Mesiaeed. Subject to confirmation, it wil be necessary for the authorities to confirm that all wastes in the Emirate are under sond regulatory control.		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	The sorting and gasification plant at Mesiaeed for domestic waste is understood to be of insufficient capacity (Design: 1400t/day) to deal with Qatars growth. To achieve waste reduction Qatar wil ned to introduce EPR policies and regulations to impact on the supply chain.		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	This will take time to introduce across Qatar requiring EPR policy and regulation affecting food producers, distrbutors, retailers and importers		2030
SDG 13, Take urgent action to combat climate change and its impacts	There are no known CDM projects in place to mitigate disposal emissions. Oman needs to commit to detailed planning of INDC targets related to reducing waste emissions and seek GCF funding to facilitate progress.		No target date

9. Saudi Arabia

Country	Saudi Arabia								Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	27,425,676	28,238,020	29,086,357	29,944,476	30,776,722	31,557,144	31,787,580		1
Urban population	Nos.	22,512,092	23,239,326	23,999,153	24,769,771	25,521,904	26,233,454	26,895,653		2
Refugee population	Nos.	582	599	577	559	561	125	136		3
GNI	US$ billion	535.25	680.92	745.67	757.62	769.90	670.76	662.24		4
GDP	US$ billion	528.21	671.24	735.97	746.65	756.35	654.27	646.44		5
Climate	Dry tropical									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	52.5	16.0	11.5	5.5	3.5	11.0			27,28
MSW Moisture content (Estimated)	% of MSW	41.7							Estimated	15,16
MSW Inert content	% of MSW	14.9							Assumed	15,16
Informal Sector Collection	% of MSW	10.0							Estimated	28
Degradable Organic Carbon (DOC)	% of MSW	11.0							Estimated	15,16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016	Excludes informal	
MSW Generation (All)	tons/year	11,554,707	12,048,014	12,560,476	13,092,794	13,645,697	14,219,936	14,699,000		27,28,29
Waste Generation Rate (MSW)	ton/inh/year	0.421	0.427	0.432	0.437	0.443	0.451	0.462		1,28,29
Waste Collection Coverage*	% of total MSW arisings	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		Assumed
Waste Collection	tons/year	11,554,707	12,048,014	12,560,476	13,092,794	13,645,697	14,219,936	14,699,000		Estimated
Industrial waste generated	tons/year	No Data	No Data	No Data	No Data	No Data	No Data	No Data		
Agricultural waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
CDW Arisings	tons/year	No data	No data	18,895,430	No data	No data	No data	20,650,231	Ramboll 2017	29
CDW generation rate	ton/inh/year	No data	No data	0.650	No data	No data	No data	0.650		1,29
E-waste (Household estimates)	tons/year	329,636	339,902	344,444	361,618	384,709	407,836	410,372	Estimated	11,12
E-waste Household Generation	Kg/inh/year	12.02	12.04	11.84	12.08	12.50	12.92	12.91	Estimated	1,11,12
E-waste (Household MSW)	% of MSW	2.85%	2.82%	2.74%	2.76%	2.82%	2.87%	2.79%	Estimated	11,12
Other Indicators										
Medical waste	tons/year	No data	No data	No data	46,355	No data	No data	No data		30
	Kg/inh/year	No data	No data	No data	1.548	No data	No data	No data		1,30
MSW treatment	% of MSW	0%	0%	0%	0%	0%	0%	9%	Ramboll 2017	29
Recycling	% of MSW	No Data	No Data	No Data	No Data	No Data	No Data	9%	Ramboll 2017	29
Disposal	% of MSW	100%	100%	100%	100%	100%	100%	91%	Ramboll 2017	29
Sanitary Dumpsites	% of MSW	32%	32%	32%	32%	32%	32%	32%	2 CDM projects	28,6
Dumpsite Controlled	% of MSW	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No data	
Uncontrolled dumpsites	% of MSW	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No data	

Financial	Units	
	Year	2016
Country	GNI/Capita	20,833
Estimated Waste Management Budget	US$/inh	27.3
Affordability upper limit (1%)	US$/inh	208
Affordability lower limit (0.6%)	US$/inh	125

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source	Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved
IWM development options costs	US$/inh	35.9	48.0	63.8	48				

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	The big 5 municipal authorities utilise sanitary or controlled disposal dumpsites sites. It is unclear what happens in rural areas		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	It is assumed that there access to waste collection systems for 100% of the population. This is subject to confirmation		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	Saudi Arabia is currently looking at detailed monitoring and inspection systems (GAMEP) for hazardous wastes and has regulatory control over hazardous wastes. It is not clear how industrial hazardous wastes or medical hazardous waste are treated or disposed. Aramco takes responsibility for oil and gas industry wastes.		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	Saudi Arabia has been seeking to implement an IWM infrastruture with plans going back to 2008. To date there is only one site that sorts recyclable wastes (in Riyadh) prior to disposal. To reduce wastes KSA will need to develop EPR policies and regulations.		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	KSA needs to develop effective EPR policies and initiatives affecting food producers, distrbutors, retailers and importers		2030
SDG 13, Take urgent action to combat climate change and its impacts	There are 2 known CDM projects in place to mitigate disposal emissions. KSA needs to commit to planning (INDC targets) to reduce waste emissions.		No target date

10. Syria

Country	Syria								Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	21,018,834	20,863,993	20,420,701	19,809,141	19,203,090	18,734,987	18,430,453		1
Urban population	Nos.	11,702,656	11,697,606	11,529,324	11,262,487	10,994,729	10,801,844	10,700,905		2
Refugee population	Nos.	1,501,442	1,242,391	975,695	666,547	677,756	581,113	562,811		3
GNI	US$ billion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	No data	4
GDP	US$ billion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	No data	5
Climate	Dry Temperate									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	65.0	10.0	12.0	4.0	2.0	7.0			43
MSW Moisture content (Estimated)	% of MSW	48.9							Estimated	16
MSW Inert content	% of MSW	10.0							Estimated	16
Informal Sector Collection	% of MSW	10.0							Assumed	
Degradable Organic Carbon (DOC)	% of MSW	11.4							Estimated	16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (All)	tons/year	5,030,272	4,996,177	4,892,954	4,749,283	4,606,784	4,497,229	4,426,852	Estimated	10,14,43
Waste Generation Rate (MSW)	ton/inh/year	0.239	0.239	0.240	0.240	0.240	0.240	0.240	Estimated	1,10,14,43
Waste Collection Coverage*	% of total MSW arisings	90.3%	85.9%	72.3%	72.4%	84.1%	72.5%	72.5%	Estimated	10,14,43
Waste Collection	tons per year	4,543,427	4,289,524	3,539,701	3,437,817	3,876,033	3,259,288	3,210,232	Conflict-May be lower	
Industrial waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
Agricultural waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
CDW Arisings	tons/year	7,500	No data	7,287	No data	No data	No data	No data		43
CDW generation rate	ton/inh/year	0.000	No data	0.000	No data	No data	No data	No data		43
E-waste (Household estimates)	tons/year	No data	No data	No data	No data	No data	No data	No data	No data	11
E-waste Household Generation	Kg/inh/year	No data	No data	No data	No data	No data	No data	No data	No data	1,11
E-waste (Household MSW)	% of MSW	No data	No data	No data	No data	No data	No data	No data	No data	11
Other Indicators										
Medical waste	tons/year	4,600	No data	No data	No data	No data	No data	No data		43
	Kg/inh/year	0.219	No data	No data	No data	No data	No data	No data		1,43
MSW treatment	% of MSW	6%	6%	0%	0%	0%	0%	0%		43
Rcyling and composting	% of MSW	3%	3%	No data	No data	No data	No data	No data		43
Disposal	% of MSW	97%	97%	100%	100%	100%	100%	100%	Estimated	43
Sanitary Dumpsites	% of MSW	0%	0%	0%	0%	0%	0%	0%	2 CDM projects	6,43
Dumpsite Controlled	% of MSW	19%	19%	20%	20%	20%	20%	20%	Estimated	43
Uncontrolled dumpsites	% of MSW	78%	78%	80%	80%	80%	80%	80%	Estimated	43

Financial	Units	
	Year	2016
Country	GNI/Capita	2,170
Estimated Waste Management Budget	US$/inh	18.4
Affordability upper limit (1%)	US$/inh	13.0
Affordability lower limit (0.6%)	US$/inh	6.5

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source
IWM development options costs	US$/inh	18.6	24.9	33.1	48

Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	Given the ongoing conflict this is unlikely to be achieved. This will required itnernational assistance		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	Given the ongoing conflict this is unlikely to be achieved. This will require international assistance		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	Given the ongoing going conflict this is unlikely to be achieved. This will require internatinal assistance		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	Given the ongoing conflict this is unlikely to be achieved. Will require EPR policy development and significant international assistance		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	Given the ongoing conflict this is unlikely to be achieved. Will require EPR policy development		2030
SDG 13, Take urgent action to combat climate change and its impacts	Given the ongoing conflict this is unlikely to be achieved. Will require INDC commitments to kiygate waste emissions with policy and implementation measures - requirung international suport and assistance		No target date

11. United Arab Emirates (UAE)

Country	United Arab Emirates (UAE)								Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	8,270,684	8,672,475	8,900,453	9,006,263	9,070,867	9,154,302	9,269,612		1
Urban population	Nos.	6,951,923	7,317,401	7,537,260	7,653,612	7,734,365	7,830,681	7,953,698		2
Refugee population	Nos.	538	677	631	603	417	663	888		3
GNI	US$ billion	289.78	351.02	375.12	392.01	403.86	359.69	350.84		4
GDP	US$ billion	289.88	350.91	374.82	390.43	403.20	357.95	348.74		5
Climate	Dry tropical									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	39.5	23.8	18.5	3.5	3.5	11.2			44,45
MSW Moisture content (Estimated)	% of MSW	46.2							Estimated	15,16
MSW Inert content	% of MSW	13.1							Estimated	15,16
Informal Sector Collection	% of MSW	10.0							Assumed	
Degradable Organic Carbon (DOC)	% of MSW	10.2							Estimated	15,16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (All)	tons/year	4,963,488	5,208,160	5,348,583	5,415,585	5,457,735	5,368,242	5,438,531	Extimated	44,46
Waste Generation Rate (MSW)	ton/inh/year	0.600	0.601	0.601	0.601	0.602	0.586	0.587	Estimated	1,44,46
Waste Collection Coverage*	% of total MSW arisings	99.9%	99.9%	99.9%	99.9%	99.9%	99.9%	99.9%	Assumed	44,46
Waste Collection Coverage*	tons/year	4,956,990	5,201,483	5,341,866	5,408,920	5,451,149	5,361,720	5,432,047		Estimate
Industrial waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
Agricultural waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
CDW Arisings	tons/year	No data	No data	20,471,042	No data	No data	No data	No data	Estimated	46
CDW generation rate	ton/inh/year	No data	No data	2.300	No data	No data	No data	No data		1,46
E-waste (Household estimates)	tons/year	136,784	143,642	145,031	149,657	156,019	162,791	164,665	Estimated	11,12
E-waste Household Generation	Kg/inh/year	16.54	16.56	16.29	16.62	17.20	17.78	17.76	Estimated	1,11,12
E-waste (Household MSW)	% of MSW	2.76%	2.76%	2.71%	2.76%	2.86%	3.03%	3.03%	Estimated	11,12
Other Indicators										
Medical waste	tons/year	No data	20,599	No data	No data	No data	No data	No data		44
	Kg/inh/year	No data	2.375	No data	No data	No data	No data	No data	Estimated	1,44
MSW treatment	% of MSW	5%	10%	25%	35%	40%	40%	40%		Estimate
Recycling and composting	% of MSW	2%	4%	11%	15%	17%	17%	17%	Before moisture loss	Estimate
Disposal	% of MSW	98%	96%	90%	85%	83%	83%	83%		Estimate
Sanitary Dumpsites	% of MSW	0%	0%	10%	10%	10%	10%	10%	Estimated	6
Dumpsite Controlled	% of MSW	98%	96%	80%	75%	73%	73%	73%		Estimate
Uncontrolled dumpsites	% of MSW	No data	No data	No data	No data	No data	No data	No data		

Financial	Units	
	Year	2016
Country	GNI/Capita	37,848
Estimated Waste Management Budget	US$/inh	55.1
Affordability upper limit (1%)	US$/inh	378
Affordability lower limit (0.6%)	US$/inh	227

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source
IWM development options costs	US$/inh	45.5	60.9	80.9	48

Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	It is understood that most of the 7 Emirates have or are taking action to phase out the use of uncontrolled dumpsites (subject to confirmation)		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	It is assumed that except for a small number of rural locations, the waste collection systems in the 7 Emirates have 99.9% coverage		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	There are federal environment laws and monitoring of hazardous, medical and oil and gas sector wastes. There are some implementation issues that relate practical on the ground measures to classify and record and track wastes which are being progressed. There is medica waste incinerator in Dubai, but it is not clear if all medical waste across the 7 Emirates is adequately controlled.		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	Many of the Emirates such as Dubai, Abu Dhabi and Sharjar are implementing IWM systems and encurgaing greater levels of recycling. The redcution of waste will depend on the introduvtion of EPR policies and regulation in the supply chain - signs this this gaining more acceptance		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	This will take time to introduce across the Emirates requiring EPR policy and regulation affecting food producers, distrbutors, retailers and importers.		2030
SDG 13, Take urgent action to combat climate change and its impacts	INDC reports require more detailed comitments to the development of waste facilities specifically to mitigate waste emissions and set future mitigation targets		No target date

12. Yemen

Country		Yemen							Notes	Country Reference
Demographic data	Year	2010	2011	2012	2013	2014	2015	2016		
Population	Nos.	23,606,779	24,252,206	24,909,969	25,576,322	26,246,327	26,916,207	27,584,213		1
Urban population	Nos.	7,490,903	7,833,948	8,188,903	8,555,280	8,930,838	9,314,623	9,706,057		2
Refugee population	Nos.	190,092	214,740	237,182	241,288	257,645	267,173	269,763		3
GNI	US$ billion	29.09	30.39	33.83	38.60	40.61	36.38	27.16		4
GDP	US$ billion	30.91	32.73	35.40	40.42	43.23	37.73	27.32		5
Climate	Dry tropical									
		Organic	Paper & Card	Plastic	Metal	Glass	Other			
MSW Characterisation	% of MSW	65.0	7.0	10.0	6.0	1.0	11.0			10,14,47
MSW Moisture content (Estimated)	% of MSW	48.4							Estimated	16
MSW Inert content	% of MSW	12.0							Estimated	16
Informal Sector Collection	% of MSW	10.0							Assumed	
Degradable Organic Carbon (DOC)	% of MSW	10.9							Estimated	16
Indicators	Units									
	Year	2010	2011	2012	2013	2014	2015	2016		
MSW Generation (All)	tons/year	3,631,000	3,813,067	3,929,486	4,048,044	4,167,907	4,288,505	4,409,561	Urban & Rural WGR	10,14,47
Waste Generation Rate (MSW)	ton/inh/year	0.154	0.157	0.158	0.158	0.159	0.159	0.160	Estimated	1,10,14,47
Waste Collection Coverage*	% of total MSW arisings	40.0%	39.5%	39.8%	40.1%	40.4%	33.6%	17.7%	Estimated	10,14,47
Waste Collection	tons/year	1,452,000	1,507,382	1,565,144	1,624,464	1,684,959	1,440,440	781,367	Country Report for	48
Industrial waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
Agricultural waste generated	tons/year	No data	No data	No data	No data	No data	No data	No data		
CDW Arisings	tons/year	299,231	317,454	336,786	337,297	379,056	402,141	426,632	Country Report for	48
CDW generation rate	ton/inh/year	0.013	0.013	0.014	0.013	0.014	0.015	0.015		Estimate
E-waste (Household estimates)	tons/year	27,239	28,025	28,319	29,651	31,496	33,394	34,186	Estimated	11
E-waste Household Generation	Kg/inh/year	1.15	1.16	1.14	1.16	1.20	1.24	1.24	Estimated	1,11
E-waste (Household MSW)	% of MSW	0.75%	0.73%	0.72%	0.73%	0.76%	0.78%	0.78%	Estimated	11
Other Indicators										
Medical waste	tons/year	25,271	27,798	30,578	33,636	37,000	40,700	44,770	Country Report for	48
	Kg/inh/year	1.070	1.146	1.228	1.315	1.410	1.512	1.623		Estimate
MSW treatment	% of MSW	0%	0%	0%	7%	7%	0%	0%		47
MSW recycled	% of MSW	No data	No data	No data	7%	7%	No data	No data		47
Disposal	% of MSW	100%	100%	100%	94%	94%	100%	100%	100% = default	47
Sanitary Dumpsites	% of MSW	0%	0%	0%	0%	0%	0%	0%	No CDM projects	6,47
Dumpsite Controlled	% of MSW	No data	No data	No data	26%	26%	No data	No data		47
Uncontrolled dumpsites	% of MSW	No data	No data	No data	68%	68%	No data	No data		47

Financial	Units	
	Year	2016
Country	GNI/Capita	985
Estimated Waste Management Budget	US$/inh	1.9
Affordability upper limit (1%)	US$/inh	5.9
Affordability lower limit (0.6%)	US$/inh	3.0

	Units	100% sanitary landfill	IWM Low cost	IWM High cost	Source
IWM development options costs	US$/inh	12.4	16.6	22.0	48

Traffic Lights	Action necessary	Policy, regulation & planning action underway	Target likely to be achieved or achieved

Sustainable Development Goals (SDGs)	Progress	Now	Target date
By 2020, eliminate uncontrolled dumping and open burning (SDGs: 6.3,11.6, 12.4)	Given the ongoing going conflict this is unlikely to be achieved. This will required itnernational assistance		2020
By 2020, ensure access for all to adequate, safe and affordable solid waste collection service (SDGs: 1.2, 11.1,11.6)	Given the ongoing going conflict this is unlikely to be achieved. This will require international assistance		2020
By 2030, ensure the sustainable and environmentally sound management of all wastes, particularly hazardous wastes (SDGs: 7,12,4,13)	Given the ongoing going conflict this is unlikely to be achieved. This will require internatinal assistance		2030
By 2030, substantially reduce waste generation through prevention and the 3Rs (reduce, reuse, recycle) and thereby create green jobs (SDGs 1, 8, 9, 12.5)	Given the ongoing going conflict this is unlikely to be achieved. Will require EPR policy development and significant international assistance		2030
By 2030, halve global per capita food waste at the retail and consumer levels and reduce food losses in the supply chain (SDGs: 2, 12.3)	Given the ongoing going conflict this is unlikely to be achieved. Will require EPR policy development		2030
SDG 13, Take urgent action to combat climate change and its impacts	Given the ongoing going conflict this is unlikely to be achieved. Will require INDC commitments to kiygate waste emissions with policy and implementation measures - requirung international suport and assistance		No target date

Country References

Ref	Demographic or Location	References	Notes
1	Population	World Bank (2017c). "Population." Accessed 20/9/2017 at https://data.worldbank.org/indicator/SP.POP.TOTL	
2	Urban population	World Bank (2017e). "Urban population." Accessed 20/9/2017 https://data.worldbank.org/indicator/SP.URB.TOTL	
3	Refugee population	World Bank (2017d). "Refugee population by country or territory of asylum." Accessed 20/9/2017 at https://data.worldbank.org/indicator/SM.POP.REFG	
4	GNI	World Bank (2017b). "GNI." Accessed 20/9/2017 at https://data.worldbank.org/indicator/NY.GNP.ATLS.CD	
5	GDP	World Bank (2017a). "GDP." Accessed 20/9/2017 at https://data.worldbank.org/indicator/NY.GDP.MKTP.CD	
6	All countries	Secretariat of the United Nations Framework Convention on Climate Change [UNFCCC] (2017). Clean Development Mechanism (CDM). Available at http://cdm.unfccc.int/	All countries
7	Global	United Nations Environment Programme [UNEP] & International Solid Waste Association [ISWA] (2015). *Global Waste Management Outlook.* Available at http://wedocs.unep.org//handle/20.500.11822/9672	Relative cost differences of waste treatment and recycling for high, middle and low-income countries
8	Global	Bhada-Tata, P. & D.A. Hoornweg (2012). *What a waste? : A global review of solid waste management.* Urban development series knowledge papers; No. 15. Washington, DC: World Bank Group. Available at http://documents.worldbank.org/curated/en/302341468126264791/What-a-waste-a-global-review-of-solid-waste-management	
9	UK	Waste and Resources Action Programme [WRAP] (2017). Gate fee report for 2017. Available at http://www.wrap.org.uk/sites/files/wrap/Gate%20Fees%20report%202017_FINAL_clean.pdf	Relative cost differences of waste treatment and recycling options
10	Bahrain, Iraq, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, UAE	Abou-Elseoud, N. (2008). "Waste management." In *Arab Environment: Future Challenges (2008 Report of the Arab Forum for Environment and Development).* Edited by Mostafa K. Tolba and Najib W. Saab, 111–126. Arab Forum for Environment and Development. Available at www.afedonline.org/afedreport/full%20english%20report.pdf	MSW*, CDW**, medical, industrial
11	Global and West Asian countries except Syria	Balde, C.P., F. Wang, R. Kuehr, & J. Huisman (2015). The global E-waste monitor—2014. United Nations University. Bonn, Germany: IAS-SCYCLE. Available at https://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf	E-waste

Ref	Demographic or Location	References	Notes
12	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE	Alghazo, J. & O. Ouda (2016). Electronic Waste Management and Security in GCC Countries: A Growing Challenge. Conference paper presented at 2nd International Conference on Integrated Environmental Management for Sustainable Development. Available at https://www.researchgate.net/publication/309537926_Electronic_Waste_Management_and_security_in_GCC_Countries_A_Growing_Challenge	E-waste
13	Bahrain, Kuwait Oman, Qatar, UAE, USA, UK	Maaded, M. Al-, N.K. Madi, R. Kahraman, A. Hodzic, & G. Ozerkan (2012) An overview of solid waste management and plastic recycling in Qatar. *Journal of Polymers and the Environment,* 20: 186–194. doi:10.1007/s10924-011-0332	
14	Jordan, Lebanon, Palestine, Syria	Arif, Sherif (2012). "The solid waste management situation in Mashreq and Maghreb countries: Update on the challenges and opportunities." Accessed 2/12/2015 at http://www.giz.de/en/downloads/giz2012-enSWEEP-Netregional-report.pdf	Economic and financial
15	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE	Dumble, P., N. Karawy, A.O. Abdel-Aziz & A.W. Abolnasr (2017). "Economic and GHG emission policy co-benefits for Integrated Waste Management planning across the GCC." In *Sustainability in the Gulf: Challenges and Opportunities (Routledge Explorations in Environmental Studies),* edited by Elie Azar & Mohamed Abdel Raouf, 228-248. New York: Routledge.	Organic, inert, moisture content and percentage of degradable organic carbon—method of estimation explained
16	Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, UAE	Dumble P. (2017). Regional development and climate change mitigation modelling of municipal solid waste emissions in the Middle East. *Water and Environment Journal,* Vol.31, No.2, p226-234, May. DOI: 10.1111/wej.12236. Available at http://onlinelibrary.wiley.com/doi/10.1111/wej.12236/full	Organic, inert, moisture content and percentage of degradable organic carbon—method of estimation explained
17	Bahrain	Ecomena (2015). "Solid Waste Management." Accessed 15/8/2015 at http://www.ecomena.org/tag/solid-waste-management/	MSW characterization
18	Bahrain	Bahrain Ministry of Works, Municipalities Affairs and Urban Planning [MOMUA] (2017). Askar Dumpsite data.	
19	Bahrain	Sabbagh, M.K. Al (2010). Case study on appropriate next steps for Integrated Sustainable Waste Management in the Kingdom of Bahrain. Master's thesis, Imperial College London, UK.	MSW
20	Bahrain	Sabbagh, M.K. Al, Velis C.A., Wilson D.C., & Cheeseman C.R. (2012). Resource management performance in Bahrain: a systematic analysis of municipal waste management, secondary material flows and organizational aspects. *Waste Management & Research,* 30(8) 813 –824. DOI: 10.1177/0734242X12441962.	MSW

Ref	Demographic or Location	References	Notes
21	Iraq	Yasir, R.A., T.E. Hussein, H.A. Khalaf, M.D. Selman, F.K. Hadi, & A.H. Semir (2012). Survey on Solid Waste Management in the Southern Governorates of Iraq. Marsh Bulletin, 7(1)(2012)69-101. Available at https://www.iasj.net/iasj?func=fulltext&aId=65995	Study looks at 2007 data for Iraq
22	Iraq	Iraq Ministry of Planning, Central Organization for Statistics and Information Technology [COSIT] (2011). Environment Survey in Iraq 2010 (Water-Sanitation-Municipal Services). Available at https://reliefweb.int/sites/reliefweb.int/files/resources/Full_Report_2732.pdf	MSW, CDW, other (Data includes MSW, demolitions and scrap collected by municipalities.)
23	Iraq	Elagroudy, S., T. Elkady & F. Ghobrial (2011). Comparative Cost Benefit Analysis of Different Solid Waste Management Scenarios in Basrah, Iraq. *Journal of Environmental Protection,* 2, 555-563 doi:10.4236/jep.2011.25064. Published online July 2011 at http://www.scirp.org/journal/jep	MSW
24	Jordan	European Union, European Environment Agency (2015). Development of a waste management information system with integrated possibilities for adjusting it to a specific IT-supported system corresponding to the country's needs: Assessment Report. SEIS Jordan Technical Assistance Action 2 (TA2), Draft 01.	Study looks at 2013 data for Jordan
25	Jordan	GIZ and SWEEP-Net (2014). "Country Report on the Solid Waste Management in Jordan." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/sites/default/files/JORDANIE%20RA%20ANG%20WEB.pdf	
26	Jordan	Jordan, Jordan Green Building Council (2016). Your Guide to Waste Management in Jordan Waste sorting informative booklet, Jordan Green Building Council. ISBN: 978-9957-8751-0-7. Available at https://library.fes.de/pdf-files/bueros/amman/12729.pdf	Treatment
27	Kuwait	Jarallah, R. Al- & E. Aleisa. 2014. A baseline study characterizing the municipal solid waste in the State of Kuwait. *Waste Management,* 34(2014) 952–960. doi:10.1016/j.wasman.2014.02.015 Available at https://www.sciencedirect.com/science/article/pii/S0956053X14000671	Study looks at 2012 data for Kuwait
28	Kuwait	Kuwait Central Statistical Bureau (2017). Annual Statistical Abstract. Accessed 20/11/2017 at https://csb.gov.kw/	MSW, CDW, agricultural, medical

Ref	Demographic or Location	References	Notes
29	Lebanon	GIZ and SWEEP-Net (2014). "Country Report on the Solid Waste Management in Lebanon." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/sites/default/files/LEBANON%20RA%20ANG%20WEB.pdf	Study looks at 2013 data for Lebanon
30	Lebanon	Lebanon, Council for Development and Reconstruction [Lebanon CDR] (2015). Collection and Disposal of Municipal Waste in Lebanon. Part IV: Project Information Memorandum. Authored by El-Khoury, R. & Partners.	MSW, CDW, agricultural, medical
31	Lebanon	Lebanon, Ministry of the Environment [MOEL], United Nations Development Programme [UNDP] & Global Environment Facility [GEF] (2015). National Greenhouse Gas Inventory Report and Mitigation Analysis for the Waste Sector in Lebanon. Available at http://climatechange.moe.gov.lb/viewfile.aspx?id=222	Greenhouse gas emissions from waste disposal (Lebanon)
32	Oman	Palanivel. T.M. & H. Sulaiman (2014). "Generation and Composition of Municipal Solid Waste in Muscat, Sultanate of Oman." APCBEE Procedia, 10 (2014) 96–102. http://dx.doi.org/10.1016/j.apcbee.2014.10.024	Study looks at 2012 data for Oman
33	Oman	COWI (2013). Waste characterization and quantification: Final industrial and hazardous waste survey, Be'ah.	Hazardous, medical
34	Oman	Harthy, M. Al (2016). Transformation of Waste Management in Oman. Presentation to ISWA Energy Recovery Working Group Meeting, West Palm Beach, FL, USA, 25 May 2016	Dumpsite elimination in Oman
35	Palestine	GIZ and SWEEP-Net (2014). "Country Report on the Solid Waste Management in Occupied Palestinian Territories." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/sites/default/files/PALESTINE%20RA%20ANG%20WEB.pdf	Study looks at 2013 data for Palestine

Ref	Demographic or Location	References	Notes
36	Palestine	GIZ and SWEEP-Net (2014). "Country Profile on the Solid Waste Management Situation in Occupied Palestinian Territories." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at www.retech-germany.net/fileadmin/retech/05_mediathek/laenderinformationen/Palaestina_PROFIL_Laenderprofile_sweep_net.pdf	Summary of key facts
37	Qatar	Qatar Ministry of Development, Planning and Statistics [MDPS] (2015). "Treated waste by type and waste management facility, Table 22." Accessed 15/5/2018 at https://www.mdps.gov.qa/en	MSW, CDW, bulky, tires, other
38	Qatar	Qatar Development Bank (2015). "Qatar: Solid Waste Management, Phase 1 Assessment." Presentation. Retrieved 15 December 2015 from http://www.qsa.gov.qa/eng/News/2013/related/24-62013/Day_1/4_Qatar-Solid%20Waste%20Mgmt%20V5.pdf	MSW
39	Saudi Arabia	Personal communication with representative of Saudi Arabia Ministry of Municipal and Rural Affairs [MOMRA] regarding UNEP GEO6 (2015).	Looks at 2007 data for Saudi Arabia
40	Saudi Arabia	Dornier Consulting (2007, 2008, 2009). Treatment and recycling of municipal solid waste in Riyadh, Jeddah, Damman — Kingdom of Saudi Arabia, Phase A-A1 to A-A6 & B-BO to B-B2, 16 February 2007 to 3 July 2009.	MSW characterization
41	Saudi Arabia	Ramboll (2017). Waste Management Assessment for Riyadh, Jeddah, Mecca, Medina and Damman pilot projects. 26 February.	MSW, CDW, commercial, medical
42	Saudi Arabia	Taha, S.M. (2013). "Hospitals generate 127 tons of biomedical waste every year." Arab News. Available at http://www.arabnews.com/news/464255	Medical
43	Syria	GIZ and SWEEP-Net (2010). "Country Report on the Solid Waste Management in Syria." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://www.sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportSyria-En-mai2011.pdf	Looks at 2002 data for Syria

Ref	Demographic or Location	References	Notes
44	UAE	Dumble, P., K.S. Williams & C.N. Lowe (2011). Key Sustainability Criteria Supporting the Development of Abu Dhabi's Integrated Waste Management Systems. Communications in Waste and Resource Management. Accessed 21/5/2015 at: www.ciwm.co.uk/CIWM/InformationCentre/CWRMJournal/CWRMpapers/CWRM_Current_Papers.aspx	Looks at 2009 data for the UAE
45	UAE	Edessa (2009). Abu Dhabi Waste Characterization Study. Reference A-203/RA/101/09, Edessa, 5 April.	
46	UAE	United Arab Emirates, Environment Agency—Abu Dhabi [EAD] (2013). Towards integrated waste management in Abu Dhabi: Annual policy brief. Copies available from customerservice@ead.ae	Medical
47	Yemen	GIZ and SWEEP-Net (2010). "Country Report on the Solid Waste Management in Yemen." German Corporation for International Cooperation [Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)] and Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), on behalf of the German Federal Ministry for Economic Cooperation and Development [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)]. Available at http://sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportYemen-En-mai2011.pdf	Looks at 2009 data for Yemen
Notes: *MSW: municipal solid waste. **CDW: construction and demolition waste.			

www.unenvironment.org

United Nations Environment Programme
P.O. Box 30552 Nairobi, 00100 Kenya
Tel: +254 20 762 1234
Fax: +254 20 762 3927
E-mail: uneppub@unep.org

UN environment programme

For more information:

UN Environment Programme (UNEP),
West Asia Office
Manama - Bahrain
Mail address P.O. Box 10880
Tel: +973 17 812 777