



Rub al Khali - world's largest sand sea,
Arabian Peninsula

Source: NASA/ISS/Flickr.com

“There was no water and too much sand...”

- **Nofa Hamid**, sheep herder from Addami village in Syria (NPR 2010)



In the drought-stricken village of Addami in northern Syria, villagers such as Nofa Hamid have abandoned their once-fertile lands that have turned to dust in search of work in cities. The massive displacement of ‘water refugees’ is happening region-wide in response to increasing water scarcity and climate change. Nofa Hamid, who has been tending sheep for almost 50 years said the summer had been ‘crazy’ and that the sand was ‘everywhere’. Sheep herders and farmers who depend on their livestock and farmlands are being forced to seek other livelihoods - many find temporary jobs in urban areas; however, the future for many sheep herders like Nofa Hamid is uncertain given the increased temperatures and significant reductions in annual average rainfall expected in the Arab region as a result of climate change. The effects of water scarcity and displacement of peoples to cities ranges greatly from unchecked sprawl, lack of basic services, increasing food insecurity, and pollution. The environment is also affected by reduced biodiversity and exacerbated soil erosion, which increases desertification. The degradation of the landscape has far reaching consequences, both social and environmental.



Just as oil largely defined the past century for the Arab region, water scarcity and desertification will likely define this century. The drought conditions in the village of Addami and the migrations of people forced to seek other livelihoods, have become commonplace in the Arab region; these conditions will worsen with increases in population, and in some cases, by conflict. Chapter 2 of this atlas describes water availability and supply as a transboundary issue, which highlights the potential for coordination and collaboration among water-sharing countries, but also emphasizes the potential for conflict over an increasingly scarce natural resource. In response, the Arab League nations are investing substantial effort and funds into developing alternative water supplies, adopting water conservation measures, and planting more water efficient crops to mitigate growing water scarcity problems. Some countries are going to extraordinary lengths to increase water supplies, such as the case with Morocco’s cloud seeding program in the Central High Atlas Mountains, where silver iodide is used as a seeding agent to increase the precipitation efficiency of cold clouds to produce snowfall and augment the snowmelt runoff in the summer, when the water is needed most. Other Arab countries are implementing extensive wastewater recycling programs and the Arab region boasts some of the largest desalination plants in the world.

With almost 40 per cent of the global population projected by 2015 to be living in countries where it is difficult or impossible to meet basic water needs, and over half of the Arab countries expected to experience severe water scarcity by 2050, these innovative methods are key to ensuring future water supplies. As the UN Committee on Economic, Social and Cultural Rights commented: ‘Water is fundamental for life and health. The human right to water is indispensable for leading a healthy life in human dignity. It is a pre-requisite to the realization of all other human rights’. Efficient water management and coordinated approaches to managing increasingly scarce natural resources in the Arab region are fundamental to ensuring a secure future for the people of this region.

ACRONYMS AND ABBREVIATIONS

ACSAD	Arab Center for Studies of Arid Zones and Drylands	MCM	million cubic metres
AFED	Arab Forum for Environment and Development	MDRI	Multilateral Debt Relief Initiative
ATDP	Arab Trade and Development Program	MDGs	Millennium Development Goals
BCE	Before the Common Era	mm	millimetres
BCM	billion (thousand million) cubic metres	MODIS	Moderate Resolution Imaging Spectroradiometer
bpd	barrels per day	MW	Megawatt
boe	barrels of oil equivalent	n.d.	no date
°C	Celsius	NO ₂	Nitrogen Dioxide
CAEU	Council of the Arab Economic Unity	NO _x	nitrogen oxides
CBD	Convention on Biological Diversity	N ₂ O	Nitrous Oxide
CEDARE	Center for Environment and Development for the Arab Region and Europe	NASA	National Aeronautics and Space Administration, United States of America
cm	centimeters	NCSA	National Capacity Self Assessments
CO	Carbon Monoxide	NOAA	National Oceanic and Atmospheric Administration, United States of America
CO ₂	Carbon Dioxide	O ₃	ozone
DAC	Development Assistance Committee	OPEC	Organization of the Petroleum Exporting Countries
EPA	Environmental Protection Agency	PCB	Polychlorinated biphenyl
ESCWA	Economic and Social Commission for Western Asia	PERSGA	Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden
FAO	Food and Agriculture Organization of the United Nations	ppm	parts per million
GCC	Gulf Cooperation Council	PM	particulate matter
GDP	Gross Domestic Product	ROPME	Regional Organisation for the Protection of the Marine Environment
GEF	Global Environment Fund	RSA	ROPME Sea Area
GEO	Group on Earth Observations	RSGA	Red Sea and Gulf of Aden
GHG	Greenhouse Gases	SIDS	Small Island Developing States
GIS	Geographic Information System	SO _x	sulphur oxides
GNP	Gross National Product	UAE	United Arab Emirates
GWh	Gigawatt Hour	µg	microgram
ha	hectares	UN	United Nations
HDI	Human Development Indicator	UNCCD	United Nations Convention to Combat Desertification
HIPC	Heavily Indebted Poor Countries	UNDP	United Nations Development Programme
IBAs	Important Bird Areas	UNEP	United Nations Environment Programme
IDPs	Internally displaced persons	UNESCO	United Nations Educational, Scientific and Cultural Organisation
IGBP	International Geosphere-Biosphere Programme	UNFCCC	United Nations Framework Convention on Climate Change
IPCC	Intergovernmental Panel on Climate Change	UNICEF	United Nations Children's Fund
IUCN	International Union for Conservation of Nature and Natural Resources	UNSD	United Nations Statistics Division
kg	kilograms	USAID	United States Agency for International Development
km	kilometres	USGS	United States Geological Survey
km ²	square kilometres	WFP	World Food Programme
km ³	cubic kilometres	WHO	World Health Organization
LDCs	Least Developed Countries	WRI	World Resources Institute
m	metres	WTO	World Trade Organization
m ²	square metres	WWF	World Wildlife Fund
m ³	cubic metres	yr	year
m ³ /sec	cubic metres per second		
Mashreq region	Egypt, Iraq, Jordan, Lebanon, Palestinian and Syria		
Maghreb region	African nations of Algeria, Libya, Morocco, Tunisia and Mauritania		

Changes in MDG Goal 7: Environmental Sustainability Indicators	Forested Land as % of Land Area		Protected area to total surface area, percentage		Access to Improved Water source (% of total population)		Access to Improved Sanitation (% of total population)		Slum Population as percentage of urban population	
	1990	2010	1990	2010	1990	2008	1990	2008	1990	2005
Algeria, People's Democratic Republic of	0.7	0.6	6.23	6.24	94	83	88	95	11.8	N/A
Bahrain, Kingdom of	0	1.4	0.16	0.74	100	100	97	97	0	0
Comoros, Union of the	6.5	1.6	0	0	87	95	17	36	65.4	68.9
Djibouti, Republic of	0.3	0.3	0.05	0.05	77	92	66	56	N/A	N/A
Egypt, Arab Republic of	0	0.1	2.08	6.08	90	99	72	94	50.2	17.1
Iraq	1.8	1.9	0.05	0.05	81	79	N/A	73	16.9	52.8
Jordan, Hashemite Kingdom of	1.1	1.1	0.73	1.94	97	96	N/A	98	16.5	15.8
Kuwait, State of	0.2	0.3	1.11	1.11	99	99	100	100	N/A	N/A
Lebanon	12.8	13.4	0.33	0.36	100	100	N/A	89	50	53.1
Libyan Arab Jamahiriya, Socialist People's	0.1	0.	0.11	0.11	54	54	97	97	35.2	N/A
Mauritania, Islamic Republic of	0.4	0.2	1.13	1.13	30	49	16	26	94.3	N/A
Morocco, Kingdom of	11.3	11.5	1.13	1.53	74	81	53	69	37.4	13.1
Oman, Sultanate of	0	0	0	9.31	80	88	85	N/A	60.5	N/A
Occupied Palestinian Territories	1.5	1.5	0.63	0.64	95	91	N/A	89	N/A	N/A
Qatar, State of	0	0	0.89	1.39	100	100	100	100	N/A	N/A
Saudi Arabia, Kingdom of	0.5	0.5	7.25	29.95	89	89	N/A	N/A	19.8	18
Somali Republic	13.2	10.8	0.53	0.53	21	30	N/A	23	96.3	73.5
Sudan, Republic of the	32.1	29.4	4.18	4.18	65	57	34	34	86.4	94.2
Syrian Arab Republic	2	2.7	0.25	0.64	85	89	83	96	10.4	10.5
Tunisia	4.1	6.5	1.22	1.27	81	94	74	85	9	3.7
United Arab Emirates	2.9	3.8	0.27	4.71	100	100	97	97	N/A	N/A
Yemen, Republic of	1	1	0	0.69	72	62	18	52	67.5	67.2

* Improvements are marked in **bold green**

Source used for country names: Permanent Mission to the United Nations, 2008.

Note: Some of the dates may vary along with the data sources- see the country profiles in Chapter 3 for further information



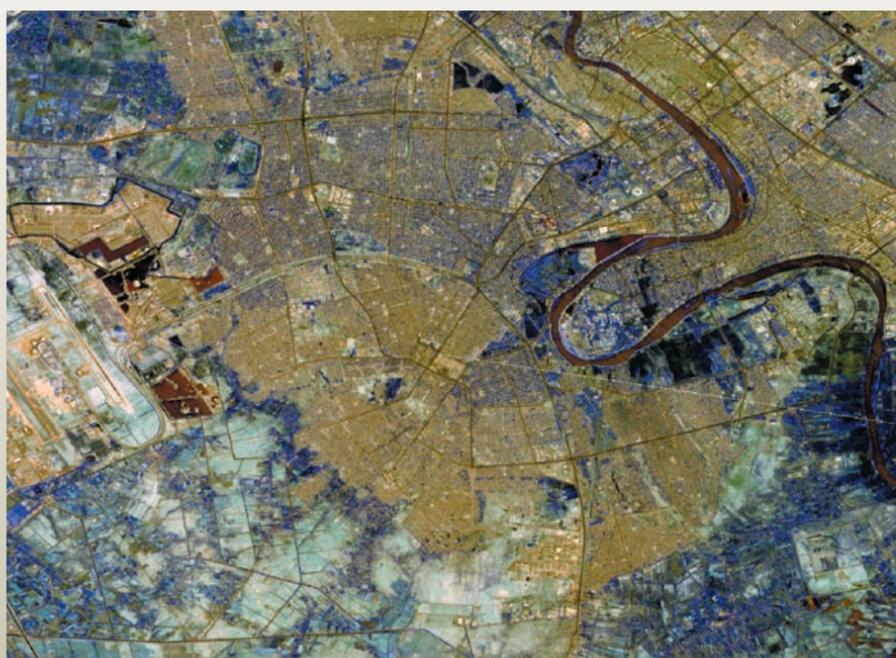
ABOUT REMOTE SENSING IMAGES

The field of Remote Sensing has grown considerably since its infancy in the early 1970s when the initial earth-observing satellite of the Landsat program was launched. The Landsat program, jointly managed by NASA and the U.S. Geological Survey, has collected and archived images of the Earth's surface for nearly 40 years. This valuable historical record provides a unique opportunity for identifying and documenting environmental change anywhere on the planet. This atlas relies heavily, although not completely, on the images provided by the Landsat Program to depict environmental change in the Arab region. Since the initial earth-observing satellite of the Landsat Program was launched in the 1970s several new satellites with improved sensors (EO-1, OrbView, IKONOS etc.) collected data at higher resolutions and with an ability to capture different portions of electromagnetic radiation (e.g. radio waves, microwaves, visible light, infrared). The improved imagery from non-Landsat satellites proved invaluable in documenting change in the Arab region. Additionally, this atlas benefited from declassified satellite data, such as the images from the CORONA program, which allowed for documenting change in the Arab region from as early as the 1960s.

Satellites, like Landsat, use "multispectral" sensors to collect reflected electromagnetic energy from the visible range (400 to 700 nanometers), as well as wavelengths that the human eye cannot see (700 to 2 350 nanometers), and thermal energy to create images of the Earth. Multi-spectral sensors divide electromagnetic radiation into a small number of "bands" or ranges of wavelength. For example Landsat-7 collects electromagnetic radiation in eight different bands or ranges of wavelength (see table). Each of these ranges of "light" can tell us something different about the Earth's surface.

Creating usable and understandable images from multi-spectral sensors entails combining three or more of the available bands and displaying them as one of the three colours of standard monitor displays: red, green and blue. Often this yields an image that is not intuitive for the non-specialist to interpret (see the image at left, below). By selecting certain bands and adjusting the distribution of brightness - the overall brightness and the contrast - a more intuitive looking image can be achieved (see the image at right, below). The images in this atlas have been adjusted so that non-expert readers can interpret these images easily.

Both of these images are from the same ASTER remote sensing image taken over Baghdad, Iraq in August of 2009. On the left, image bands are shown as red, green and blue, with the contrast and brightness determined by



1 ASTER (The Advanced Spaceborne Thermal Emission and Reflection Radiometer) is a sensor aboard the TERRA satellite is a joint effort between National Aeronautics and Space Administration (NASA) and Japan's Earth Remote Sensing Data Analysis Center (ERSDAC).
2 MODIS (Moderate Resolution Imaging Spectroradiometer) is a sensor carried on NASA's TERRA and AQUA satellites.

The specific sensors and the band combinations used in Chapter Three can be found in the references at the end of the chapter.

In general, images are displayed so that live vegetation shows as various shades of green. Coniferous forests are generally darker shades of green, as are mangroves. Broadleaf forests are typically depicted as a slightly brighter shade of green. Agricultural fields with actively growing crops are shown as an even brighter shade of green; however this is dependent on the crop and its state of growth. The patterns of brightness are often important clues as to the nature of the vegetation. Senescent or inactive vegetation generally appears as shades of grey and brown.

Water bodies are often blue to black in appearance; however when sediment is present or the water is shallow it will appear lighter, even taking on a pink cast. Areas of bare ground will show as bright, usually almost white, while urban areas and roads generally appear as a shade of pale purple. Clouds, when they cannot be avoided, will appear as bright white.

As mentioned above, data from other sensors, such as ASTER¹ and MODIS², as well as the high resolution commercial sensors QuickBird³ and IKONOS⁴, were used in the production of this atlas. Readers will note the number of black and white images in the atlas, which were collected by the declassified satellite CORONA⁵. Corona was the United States first photo reconnaissance satellite system, operating from August 1960 until May 1972. The program was declassified in February 1995.

Landsat-7 ETM+Bands		
Band	Spectral Range (nm)	Description
1	450 to 515 nm	blue-green light
2	525 to 605 nm	green light
3	630 to 690 nm	red light
4	775 to 900 nm	near-infrared radiation
5	1 550 to 1 750 nm	mid-infrared radiation
6	10 400 to 12 500 nm	thermal-infrared radiation
7	2 090 to 2 350 nm	mid-infrared radiation
8	520 to 900 nm	pan-chromatic

the default settings of a standard Geographic Information System software program. On the right, bands are displayed as red, green and blue and the colour balance, contrast and brightness have been adjusted.



3 QuickBird is a high resolution commercial multispectral sensor aboard the QuickBird satellite, operated by DigitalGlobe.
4 IKONOS is a high resolution commercial multispectral sensor aboard GeoEye's IKONOS satellite.
5 Corona is a U.S. photographic surveillance satellite flown from the 1960s through the 1970s.

A

Abu Dhabi (UAE) 12, 23, 25, 48, 74, 75, 88, 268, 269, 274
 Aden (Yemen) xiv, 282, 283
 afforestation 105, 106, 107, 113, 173, 275
 Also see reforestation
 agriculture xii-xiv, 10, 14, 26, 27, 61, 99, 140, 141, 163, 170-171
 Ahaggar Mountains (Algeria) 6
 air pollution xiii, 73-75
 Air Quality Index 74
 Asian brown cloud 79
 fire 75, 79, 176
 gas flares 49
 major air pollutants 74, 104
 oil and gas industry xiv, xv, 49, 74, 75, 149, 165, 168, 175-177, 181, 227
 secondary air pollutants 74, 104
 transboundary 74, 75, 77-79
 vehicle emissions 74, 75, 77-79
 Al Ain (UAE) 270-271
 Al Muharraq Island (Bahrain) 120-121
 Al Wahda Reservoir (Morocco) 200-201
 Algeria xi, xiv, xv, 3-6, 10, 12, 13, 16, 20-22, 24-28, 31, 34, 40, 41, 43, 46-49, 58, 60-61, 70-71, 74, 75, 79, 82, 83, 91, 106-113, 297
 Algiers (Algeria) 23, 75, 107-111
 Amman (Jordan) 22, 23, 68, 158, 159, 162, 163
 An Nafud Desert (Saudi Arabia) 6
 Anjouan Island (Comoros) 126-129
 Aqaba (Jordan) 68, 160-161
 aquifer systems 14, 15, 53, 54, 62, 68
 Nubian Sandstone Aquifer 69, 184, 185
 QaDisi Aquifer 68
 North Sahara Aquifer 70
 Arab League x, xiv, xv, 17, 61, 81, 105, 295
 aridity zones 57
 Asian Brown Cloud 79
 Asi-Orontes River Basin 62, 63, 67
 Asir Mountains 6, 37
 Atlantic Ocean 47, 78, 194, 203
 Atlas Mountains 4, 6, 10, 61, 113, 196
 Az Zarqa River (Jordan) 156
 Azraq Wetland Reserve (Jordan) 162-163

B

Baghdad (Iraq) 22, 23, 28, 29, 74, 150, 151, 298
 Bahrain x, xiv, 12, 20-22, 24-27, 34, 41, 43, 58, 60, 74, 75, 83, 91, 114-121, 297
 Barada River (Syria) 255
 Basrah (Iraq) 94, 95, 148, 149
 Beirut (Lebanon) 22, 23, 29, 75, 92, 172, 174-175, 177
 Beqaa Valley 6, 172
 biodiversity xi, 31-39
 hotspots 32, 33
 loss xiii, xiv, 20, 36, 58, 59, 84-88, 96, 139, 161, 179, 242, 243, 245, 253, 269

threats and conservation xiv, 11, 36-39, 97, 115, 123, 126, 127, 136, 137, 157, 213, 237, 282, 283
 flyways 35

C

Cairo (Egypt) 20, 22, 23, 28, 29, 75, 79, 139-143
 carbon dioxide (CO₂) emissions xiii, 58, 59, 74, 75, Casablanca (Morocco) 23, 196, 198, 199
 charcoal production 10, 123, 179, 237, 241-243, 259
 chlorophyll 88
 climate 4, 5, 10, 11, 46, 47
 climate classification 4, 5
 climate change xii, xiii, 4, 14-17, 48, 49, 56-59, 74-75, 91 139-140, 157
 Mediterranean climate 4, 5
 Global Land Surface Temperature 46
 Global Sea Surface Temperature 47
 Comoros Islands xiv, 16, 17, 21, 22, 24, 26, 27, 33, 41, 43, 59, 60, 75, 83, 122-129
 conflict xv, 12, 20, 24, 26, 42, 62, 63, 64
 and environmental degradation xv, 93-95, 148-150
 and displacement xv, 90-93, 98, 99, 239, 245
 coral reefs 83-85, 87, 123, 131, 136, 137, 157, 213, 221, 269, 272-273, 282
 Crown of Thorns 85, 137
 culture 28, 29, 102, 153
 Cyclone Gonu 16, 17, 47, 215, 218, 219

D

Damascus (Syria) 23, 29, 75, 92, 254, 255
 Damietta River (Egypt) 39, 140, 141
 Dammam (Saudi Arabia) 234, 235
 dams 33, 67
 Al Wahda 200, 201
 Aswan High Dam 29, 66, 139, 140, 146, 149, 249
 Ataturk 154
 Bou Hertma 266, 267
 Dlama 194, 195
 Fom Gleita 192, 193
 Manantall 194, 195
 Merowe Dam 248, 249
 Mosul Dam 65
 Sidi el Barrak 267
 Darfur (Sudan) 47, 99, 245
 Dead Sea 6, 7, 89, 156, 204, 206, 207
 deforestation xiii, xiv, 10, 99, 105, 107, 112, 113, 122, 123, 126, 127, 149, 157, 173, 205, 237, 243, 253, 258, 259
 desalination 14, 71, 87, 106, 107, 119, 165, 181, 213, 225, 228, 229, 261, 268
 desert xiii, 4-6, 11, 49
 An Nafud 6
 Al Dhana 6
 Danakil 134
 Eastern Desert 138
 Rub Al Khali 6, 228, 274, 276
 Sahara 4-6, 16, 76-78, 106, 182, 188, 189, 191,

260

Syrian 6, 154

Western Desert 69, 138

desertification xiii, xiv, 10, 11, 49, 57, 91, 96, 107, 131, 149, 157, 165, 181, 189, 191, 197, 221, 229, 237, 243, 245, 253, 261, 269, 277

Dhahran (Saudi Arabia) 88, 168, 234

Dhofar Mountains (Oman) 38, 216, 217

Djibouti xiv, 6, 12, 17, 20, 21, 22, 24, 26, 27, 41, 43, 58, 60, 75, 83, 91, 130-137, 297

Djibouti City (Djibouti) 132-133, 137

Doha (Qatar) 220, 222-223, 225

Dubai (UAE) 22, 23, 26, 29, 74, 75, 272-273

dugong 30, 36, 38, 83, 123, 221

Durrat Al Bahrain Island (Bahrain) 118-119

dust storms 16, 17, 74-78, 212

E

Earth Observations 44-47, 49, 296

earthquakes 16, 17

economics xi, xii, 12, 14, 15, 24-28, 42, 43, 62

education 20, 21, 24, 42, 43, 104

Egypt xiv, 4, 12-14, 16, 20-29, 35, 40, 41, 43, 44, 46, 59, 60, 62, 63, 66, 67, 69, 74-77, 83, 91, 96, 138-147, 297

elephant 237, 245

Ethiopian Highlands 6, 66

Euphrates River 15, 33, 58

eutrophication 88, 145, 263

F

Fertile Crescent 58, 150

fertility rates 20, 41, 277

fires 17, 75, 79, 112, 149, 168, 169, 173, 177, 178, 179, 197, 250, 253, 258, 259

fisheries resources 81-83, 115, 123, 131, 171, 189, 221, 283

overfishing 82, 83, 136, 137, 189, 264, 283

forests xiii, 10, 32-34, 37, 83, 105, 107, 112, 113, 123, 126, 127, 149, 173, 178, 179, 189, 197, 210, 211, 216, 217, 237, 242, 245, 252, 253, 258, 261, 297

Fom Gleita Dam (Mauritania) 192, 193

G

Gaddafi, Muammar 184

gas flaring 49

Gaza Strip (Palestine) 23, 98, 204, 205

geology 7, 12

tectonic plates and faults 7, 8, 9, 16

rock types 7

geomorphology 6

Golan Heights 62, 98

Gorgol River (Mauritania) 192, 193

Great Man-made River Project (Libya) 69, 180, 182, 184

Great Rift Valley 6, 7, 16, 80

Greater Burgan Oil Field (Kuwait) 12, 168, 169

greenhouse gases 46, 58, 59, 74, 75, 105, 297

INDEX

gas flaring 49
Gross Domestic Product (GDP) 26-28, 42
Gross National Income (GNI) 26
Gulf Cooperation Council (GCC) x-xiii, 10, 13, 14, 20, 24, 27, 28, 71, 75
Gulf of Aden 82, 83, 87, 88, 134, 282
Gulf of Aqaba 87, 156, 157, 160, 161
Gulf of Suez 87
Gulf War 87, 92, 159, 165, 170

H

Hadramawt Mountains (Yemen) 6
Hail Province (Saudi Arabia) 232, 233
Hajar Mountains (Oman, UAE) 214, 268, 270
Hargeysa (Somalia) 240, 241
Harrat Khaybar (Saudi Arabia) 6, 7
Hauran-Hammad Plateau (Syria) 6
Hejaz Mountains (Saudi Arabia) 6
Horn of Africa 6, 32, 33, 91, 132, 136
Human Development Indicator (HDI) 24
hydrocarbon
 exploration 47, 186, 187
 production xii, 3, 12, 13, 25, 75, 107, 116, 165, 181, 212, 220, 222, 229, 244, 245, 269
 geology 7, 12
 reserves 3, 12, 13, 25, 114, 181, 182, 244
 oil fields 12, 13, 116, 117, 130, 131, 160, 169, 171, 228
 dependency 12, 26-28, 114, 212, 245
hydropower 64-67, 195, 200, 248

I

Important Bird Areas (IBAs) 33-35, 154
Indian Ocean 6, 16, 33, 47, 58, 59, 131
Internally Displaced Persons (IDPs) 91, 93, 99, 149, 241, 244
 also see Migration
invasive species 36, 39, 85, 89, 123, 125, 139, 253
Iraq xiv, 3, 5, 12, 14, 21, 22, 24-27, 29, 31-33, 40, 41, 43, 49, 58, 60-65, 74-76, 83, 91-97, 148-155, 297

J

Jabal Abu Ghneim (Palestine) 210, 211
Jebel Hafit Mountain (UAE) 270, 271
Jiyeh Power Plant (Lebanon) 92, 173, 176, 177
Jonglei (Sudan) 250, 251
Jordan xiv, 5, 11-14, 21, 22, 24-27, 29, 40, 41, 43, 58, 60, 63, 68, 75, 76, 83, 89, 91, 93, 98, 156-163, 297
Jordan River 6, 15, 58, 63, 89, 176, 205-207
Jordan Valley (Palestine) 156, 206-207
Jubba River (Somalia) 236, 237

K

Karkaar Mountains (Somalia) 6
Karthala Volcano (Comoros) xii, 122, 124, 125
Khartoum (Sudan) 246-248
King Fahd Causeway 114, 116

Kismaayo (Somalia) 242, 243
Kuwait xiv, 11, 12, 17, 21, 22, 24-28, 30, 40, 41, 43, 48, 58, 60, 71, 75, 82, 83, 91, 92, 96, 97, 164-171, 297
Kuwait City (Kuwait) 23, 74, 165-167, 169

L

Lake Assal (Djibouti) 6, 134, 135
Lake
 Assal 6, 134, 135
 Bizerte 61
 Burullus 140, 144, 145
 Dead Sea 6, 7, 89, 156, 204, 206, 207
 Foum Gleita 192, 193
 Hawr al habbaniya 154, 155
 Ichkeul 61
 Idku 140
 Lawzi 115
 Manzala 140, 141
 Maryut 140, 141
 Nasser 66, 139, 171
 Razazah 154, 155
land reclamation 33, 115, 117-119, 145, 223, 235, 259
land
 conversion 105, 157, 183, 247
 cover 10, 11, 49, 253
 degradation xii-xiv, 11, 49, 54, 76, 99, 157, 163, 165, 167, 179, 191, 197, 199, 205, 221, 229, 245, 251, 253, 259, 261, 269, 277
 resources 10-13, 170
 use 11-13, 48, 49, 97, 116, 123, 131, 133, 165, 197, 235, 277

Latakia (Syria) 258, 259
Lawzi Lake (Bahrain) 115
Least Developed Countries (LDCs) 27, 42, 104
Lebanon xiv, 6, 12, 14, 16, 17, 19-22, 24, 26, 27, 29, 40, 41, 43, 58, 63, 67, 75, 83, 91, 92, 96, 172-179, 297
Lebanon Mountains 5, 6, 173
Lessepsian species 85
Libya xiv, 6, 12-14, 21, 22, 24-28, 40, 41, 43, 47, 60, 69-71, 75, 79, 91, 180-187, 297
Literacy 19-21, 28, 42, 104
Liwa (UAE) 274, 275
Lusail City (Qatar) 224, 225

M

Ma'ale Adumim Colony (West Bank, Palestine) 208, 209
Maghreb x, 24, 27, 32, 36
malnutrition 22, 23, 131, 148, 237
Manama (Bahrain) 74, 116, 117, 120, 121
Mandab Strait 6
mangrove ecosystems 10, 33, 34, 48, 83, 115, 215, 221, 276, 282
Manzala Lake (Egypt) 140, 141
Marsh Arabs 93, 149, 153
Mashreq x, 10, 13, 20, 24, 25, 27, 32, 82
Maskali Island (Djibouti) 131, 136, 137

Mauritania x, xiv, 12-14, 20-22, 24-27, 40, 41, 43, 60-63, 76, 83, 91, 188-195, 297
Merowe Dam (Sudan) 248, 249
Mesaieed Industrial City (Qatar) 226, 227
Mesopotamian Marshlands (Iraq) 33, 93, 149, 152, 153
migration 20, 54, 59, 91, 92, 106, 159, 181, 254
migratory birds 35
Millennium Development Goals (MDGs) xiii, 23, 35, 42, 103-105, 297
mineral resources 7, 13, 25, 47, 156
Mogadishu (Somalia) 236, 238, 239
mountains
 Ahaggar 6
 Asir 6, 37
 Atlas 4, 6, 10, 61, 113, 196
 Hadramawt 6
 Hajar 214, 268, 270
 Hejaz 6
 Jebel Hafit 270, 271
 Karkaar 6
 Lebanon 5, 6, 173
 Taurus 6, 7
 Zagros 6, 7, 32
Morocco xiv, 6, 12, 13, 16, 17, 20-22, 24-27, 34, 40-41, 43, 58, 60, 75, 78, 82, 83, 91, 129-203, 297
Moroni (Comoros) 122
Muscat (Oman) 17, 213-215
Musha Island (Djibouti) 136, 137
Mutsamudu (Comoros) 128, 129

N

natural gas 3, 2, 13, 49, 75, 107, 181, 212
Nasser Lake (Egypt) 66, 139, 171
natural hazards 16, 17
 fires 16, 17, 57, 75, 79, 112, 258, 259
 cyclones 16, 17, 47, 122, 215, 218, 219, 280, 281
 earthquakes 16, 17
 floods 16, 17, 58, 59, 91, 106, 202, 203, 290, 291
 dust storms 16, 17, 74-78, 212
 Asian Brown Cloud 79
Nile Delta 26, 58, 59, 66, 140, 141, 146, 147
Nile River 59, 66, 67, 138-141, 146, 147, 244, 245, 248
North Sahara Aquifer System 70
Nouadhibou (Mauritania) 188
Nouakchott (Mauritania) xiii, 188-191
Nubian Sandstone Aquifer 69, 184, 185

O

Occupied Palestinian Territories xiv, 14, 20-22, 24, 26, 27, 29, 41, 43, 58, 60, 63, 75, 91, 98, 204-211, 297
oil
 dependency 12, 26-28, 114, 212, 245
 exploration 47, 186, 187
 fields 12, 13, 116, 117, 130, 131, 160, 169, 171, 228
 production xii, 3, 12, 13, 25, 75, 107, 116, 181, 165, 212, 220, 222, 229, 244, 245, 269

reserves 3, 12, 13, 25, 114, 181, 182, 244
 Oman xiv, 12, 21, 22, 24, 26-28, 38, 40, 41, 43, 47, 48, 60, 75, 83, 88, 91, 212-219, 297
 Organization of the Petroleum Exporting Countries (OPEC) 12, 13

P

Palm Islands (Lebanon) 34, 177
 Pearl City (Qatar) 224, 225
 phosphate 13, 25, 156, 161, 261, 264
 phytoplankton 79, 89
 bloom 89, 110, 111
 pollution
 air xiii, 73-75, 77-79, 49, 104, 109, 165, 168, 175-177, 181, 199, 205, 227, 261
 marine 82, 85-87, 107, 111, 115, 123, 131, 173, 181, 197, 213, 227, 261
 Mediterranean 86-88
 Red Sea and Gulf of Aden 86-88
 ROPME Sea Area 71, 86-88
 population demographics 20, 91, 220
 population growth xii-xiv, 14, 19-23, 26, 28, 41, 91, 107, 122, 139, 140, 142, 149, 150, 166, 173, 205, 221, 226, 229, 230, 252, 258, 271, 277, 278
 poverty 20, 22, 26, 27, 42, 91-93, 98, 99, 122, 130, 236, 237
 protected areas xi, xii, 11, 34-36, 43, 54, 55, 96, 97, 106

Q

Qassim Province (Saudi Arabia) 232, 233
 Qatar xiv, 12-14, 20-22, 24-28, 41-43, 48, 58, 60, 75, 83, 91, 220-227, 297
 Qatif Island (Saudi Arabia) 234, 235
 Quryat (Oman) 218, 219

R

Rabat (Morocco) 23, 75, 202, 203
 Red Sea 6, 7, 34-36, 80-89, 156
 reforestation 105-107, 113, 123, 173
 Also see afforestation
 refugee camps
 Baqa (Jordan) 159
 Beach (Gaza Strip, Palestine) 205
 Marka (Jordan) 159
 Refugees 91-93, 98, 99, 205, 244, 254
 Also see migration
 remote sensing 45-49, 298
 river basin
 Asi-Orontes River Basin 62, 63, 67
 Euphrates-Tigris River Basin 62-65
 Jordan River Basin 63
 Juba-Shebali River Basin 62, 63
 Medjedra River Basin 61, 62
 Nahr el Kabir Janoubi 62
 Senegal River Basin 63, 194
 Yarmouk 62

river

Asi 67
 Az Zarqa 156
 Barada 255
 Damietta 59, 140, 141
 Euphrates 15, 33, 58, 64, 65
 Gorgol 192, 193
 Jordan 6, 15, 58, 63, 89, 176, 205-207
 Juba 236, 237
 Nile 59, 66, 67, 138-141, 146-147, 244, 245, 248
 Orontes 67
 Rosetta 59, 140, 141
 Senegal 14, 62, 63, 188, 189, 194, 195
 Shabeelle 236, 237
 Tigris 64, 65, 149-152
 Yarmuk 156
 Riyadh (Saudi Arabia) 23, 230, 231
 ROPME Sea Area 34, 58, 82, 83, 84, 87, 88
 Rosetta Promontory (Egypt) 146, 147
 Rosetta River (Egypt) 59, 140, 141
 Rub Al Khali Desert (Empty Quarter) 6, 228, 274, 276

S

Sahara Desert 4-6, 16, 76-78, 106, 182, 188-191, 260
 Sana'a (Yemen) 22, 23, 74, 278, 279
 Saudi Arabia xiv, 11-14, 20-22, 24-28, 34, 37, 40-43, 46, 68, 71, 75, 78, 87, 91, 96, 228-235, 297
 Seagrasses 38, 48, 83, 84, 87
 seas
 Atlantic Ocean 47, 78, 194, 203
 Indian Ocean 6, 16, 33, 47, 58, 59, 131
 Mediterranean 39, 82-86
 Red Sea 6, 7, 34-36, 80-89, 156
 ROPME Sea Area 34, 58, 82-84, 87, 88
 transboundary issues 81, 82, 84-86, 88, 110
 security 24, 43, 92, 93, 98, 99
 seismic hazard zones 8, 9, 16
 Senegal River (Mauritania) 14, 62, 63, 188, 189, 194, 195
 Shabeelle River (Somalia) 236, 237
 Sinai Peninsula 6, 7, 16
 Sitrah Island (Bahrain) 116
 Skikda (Algeria) 112, 113
 Small Island Developing States (SIDS) 59
 Socotra Island (Yemen) 33, 43, 83, 276
 Soils 11
 Somalia xiv, 10, 12, 20-22, 24, 26, 27, 40-43, 60, 63, 83, 91, 99, 236-243, 297
 Strait of Gibraltar 6
 Strait of Hormuz 6, 87
 Sudan xiv, 10, 12, 20-28, 40-43, 60, 63, 66, 67, 75, 82-84, 91, 99, 244-251, 297
 Suez Canal 6, 13, 95-97
 Syria xiv, 5, 12-14, 17, 21, 22, 24-27, 29, 40, 43, 60, 62-65, 67, 75, 83, 91, 92, 98, 252-259, 297

T

Tartus (Syria) 256, 257
 Tarut Island (Saudi Arabia) 234, 235
 Taurus Mountains 6, 7
 threatened species
 Arabian leopard 36-38
 Arabian wolf 37
 Arabian oryx 36, 38, 157, 220
 Caracal 37
 rock hyrax 37
 striped hyena 36, 37
 dorcass gazelle 36, 38
 Northern Bald Ibis 36, 38
 Dugong 30, 36, 38, 83, 123, 221
 Mediterranean monk seal 36, 38, 39, 94
 Tigris River (Iraq) 64, 65, 149-152
 Tunisia xiv, 12, 13, 20-22, 24-27, 40, 41, 43, 58, 60, 70, 74, 75, 83, 91, 260-267, 297

U

UNESCO World Heritage Sites 25, 29, 43
 United Arab Emirates (UAE) xiv, 12-14, 20-22, 24-27, 40, 41, 43, 45, 58, 60, 71, 74, 75, 83, 91, 268-275, 297

W

water quality 15, 62, 64, 70, 98, 115, 131, 143, 145, 183, 205, 207, 229, 247, 253, 261, 277
 water resources 14, 15, 22, 40, 58, 60-63, 68, 71, 91, 98, 107, 131, 157, 185, 189, 205, 213, 221, 237, 245, 253, 260, 261, 269
 water scarcity (illustration in Chap 2) xii, xiv, 14, 15, 20, 22, 60, 62, 107, 131, 139, 157, 165, 181, 189, 197, 205, 213, 221, 229, 237, 245, 253, 261, 269, 277
 wetlands 10, 33-35, 99, 115, 149, 188, 250, 252
 Wetlands of International Importance 33, 107, 152-154, 162, 163

Y

Yemen xiv, 12, 16, 17, 20-24, 26, 27, 33, 37, 40-43, 58, 60, 63, 75, 82, 83, 91, 99, 276-283, 297

Z

Zagros Mountains (Iraq) 6, 7, 32

ACKNOWLEDGEMENTS

This publication was generously funded by the Abu Dhabi Global Environmental Data Initiative (AGEDI) and the Environment Agency Abu Dhabi (EAD), in addition to funding from the United Nations Environment Programme (UNEP) and the State of Qatar.

Collaborating Partners

eMISK
Environment Public Authority, Kuwait
Regional Organization for the Protection
of the Marine Environment

Atlas Production Team

Core Team

Adel Abdel-Kader, UNEP
Ashbindu Singh, UNEP
Matthew Broughton, UNEP
Yasmina Adra, UNEP (formerly)
Cathrine Armour, AGEDI (formerly)
Faris Sayegh, Geographic Planning
Collaborative, Inc (formerly)
Jane Glavan, AGEDI
Zach Hill, Ecosystem Sciences

Coordinating Lead Authors

Shannon Campbell, Ecosystem Sciences
Zach Hill, Ecosystem Sciences

Scientific and Technical Editor

Shannon Campbell, Ecosystem Sciences

Mapping and Cartography

Tim Maguire, Ecosystem Sciences
Zach Hill, Ecosystem Sciences

Reviewing Editor

Yasmin Aziz, UNEP Consultant

Design, Layout and Graphics

Zach Hill, Ecosystem Sciences

Satellite Image Processing and Scientific Research

Aditya Agrawal, Geographic Planning
Collaborative, Inc
Bruce Pengra, UNEP
Derek Risso, Ecosystem Sciences
Tim Maguire, Ecosystem Sciences
Zach Hill, Ecosystem Sciences

Scientific Data and Research Support Team

Rania Bou Kheir, Lebanese University
Tamsen Binggeli, Ecosystem Sciences
Zach Herzfeld, Ecosystem Sciences

Web Development

Michelle Anthony, UNEP

Lead Authors

Abdullah Droubi, ACSAD (formerly)
Ahmed El-Kholei, Menofia University
Farid Chaaban, American University of
Beirut
Karim Jisr, Ecodit
Mahmoud Khamis El-Sayed, Alexandria
University
Mohammad S. Abido, Damascus
University/Arabian Gulf University
Mohammad Khawlie, National Centre for
Remote Sensing
Rami Zurayk, American University of
Beirut
Shannon Campbell, Ecosystem Sciences
(formerly)
Tim Maguire, Ecosystem Sciences
Zach Hill, Ecosystem Sciences

Other Contributors

Abdellatif Elmahrari, Morocco
Abdu Solh, Yemen
Ahmad Hussein Abdul Rahman, Qatar
Al Mahdi Rahmani, Qatar
Andrew Bauman, Canada
Balgis Elasha, Sudan
Chadi Badra, Syria
David Feary, Canada
Edwin Grandcourt, UAE
Enas Obeidat, Jordan
Fahad Alarifi, Saudi Arabia
Ghada Mahmoud, Egypt
Hassan Mohammadi, ROPME, Kuwait
Huda Al-Munayes, Kuwait
Huda Al Houqani, UAE
Hussein Shahin, Jordan
John Burt, UAE
Joy Jadam, Lebanon
Kamel Sheikho, Saudi Arabia
Khaled Salem, Occupied Palestinian
Territories
Marwan Dimashki, eMISK, Kuwait
Mohamed Dawoud, UAE
Mohammad Dawod Al-Ahmad, eMISK,
Kuwait
Mohammed Bukhari, Saudi Arabia
Mohammed Al-Ghamdi, Saudi Arabia
Mona Kamal, Egypt
Morad Sola, Libya
Mouza Al Mansouri, UAE
Mubarak Khalifa Al-Dosari, Qatar
Myyas Al Quarqaz, UAE
Nasra Al-Harthy, Oman
Nouri Soussi, Tunisia
Patty Farah, Lebanon
Rashid Al Kuwari, Qatar
Saadeldin Mohamed, Sudan
Saif Al-Bahry, Oman
Sanaa Sairawan, Lebanon
Suhad Al Shehabi, Bahrain
Wisam Mohammed, Bahrain
Yasser Othman, UAE
Zainab AlHerz, Bahrain

Reviewers

Adel Yehia, EIN Shams University
Ali Amasha, Regional Center for Disaster
Risk Reduction
Anil Kumar, Environment Agency Abu
Dhabi
Asma Abahussain, Arabian Gulf University
Derek Risso, Ecosystem Sciences
Edwin Grandcourt, Environment Agency
Abu Dhabi
Essam Ahmed, Egyptian Environmental
Affairs Agency
Faris Sayegh, Geographic Planning
Collaborative, Inc
Hesham Mohamed, Arabian Gulf
University
Islam Abou El-Magd, CSci, National
Authority for Remote Sensing and
Space Sciences - Egypt
Jane Glavan, Environment Agency Abu
Dhabi
Khaled Salem, Environment Quality
Authority - Palestine
Laila Al Hassan, Environment Agency
Abu Dhabi
Mahmoud Ali Abdelfattah, Environment
Agency Abu Dhabi
Mark Hill, Ecosystem Sciences
Mohamed Dawoud, Environment Agency
Abu Dhabi
Mohammad Abido, Arabian Gulf
University
Mostafa Foda, Egyptian Environmental
Affairs Agency
Peter Petrov, Regional Organization for
the Protection of the Marine
Environment
Rabah Lahmar, UR Systemes de Culture
Annuels
Richard Perry, Environment Agency Abu
Dhabi
Scot Smith, University of Florida
Wadid Erian, Arab Center for the Study
of Arid Zones and Dry Lands

UNEP Extended Team

Charles Davies
Charles Sebukeera
Frank Turyatunga
Habib El-Habr
Iyad Abumoghli
Melanie Hutchinson
Mona Radwan
Monika MacDevette
Peter Gilruth

EAD Extended Team

Anil Kumar
Edwin Grandcourt
Entesar Al Hosani
Huda Al Houqani
Mohamed Dawoud
Mouza Al Mansouri
Yasser Othman

Outreach and Communications

Larissa Owen, AGEDI
Marie Daher Corthay, UNEP
Neeyati Patel, UNEP
Nick Nuttall, UNEP



Source: NASA, ISS Flickr.com