SUSTAINABLE LAND MANAGEMENT AND RESTORATION IN THE MIDDLE EAST AND NORTH AFRICA REGION

Issues, Challenges, and Recommendations

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ISSUES, CHALLENGES, AND RECOMMENDATIONS

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ACRONYMS AND ABBREVIATIONS

ADLI	Agricultural Development-Led Industrialization
AFR100	African Forest Landscape Restoration Initiative
AOAD	Arab Organization for Agricultural Development
CA	Conservation Agriculture
CANA	Conservation Agriculture for North Africa
CBD	Convention on Biological Diversity
CEN-SAD	Community of Sahel-Saharan States
CGIAR	Consultative Group on International Agricultural Research
CIF	Climate Investment Fund
cm^3	Cubic centimeters
CO_2	Carbon dioxide
CSR	Corporate Social Responsibility
°C	Degrees Celsius
DFI	Development Finance Institution
ELD	Economics of Land Degradation
FAO	Food & Agriculture Organization
FMNR	Farmer-Managed Natural Regeneration
GCF	Global Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gas
GHI	Global Hunger Index
GLADA	Global Assessment of Land Degradation and Improvement
GLASOD	Global Assessment of Soil Degradation
ha	Hectares
ICARDA	International Center for Agricultural Research in the Dry Areas
IDA	International Development Association
IDFC	International Development Finance Club
IFAD	International Fund for Agricultural Development
ILK	Indigenous and Local Knowledge
ILM	Integrated Landscape Management
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JOD	Jordanian Dinar
JRC	Joint Research Centre
km^2	Square kilometers
LDN	Land Degradation Neutrality
LRI	Lebanon Reforestation Initiative

Maghreb	Algeria, Morocco, Tunisia, Libya, and Mauritania
Mashreq	Iraq, Jordan, Lebanon, Syria, and West Bank and Gaza
ME-WLI	Middle East Water and Livelihoods Initiative
MENA	Middle East and North Africa
MENA-DELP	Middle East and North Africa-Desert Ecosystems and Livelihoods Programme
MERET	Managing Environmental Resources to Enable Transition
MDB	Multilateral Development Banks
MWE	Ministry of Water and Environment
NASA	National Aeronautical Space Agency
NDVI	Normalized Difference Vegetation Index
NGO	Nongovernmental organization
NRM	Natural Resources Management
NTFP	Non-Timber Forest Product
OSS	Sahara and Sahel Observatory
PACD	Plan of Action to Combat Desertification
PES	Payment for Ecosystem Services
PPP	Purchasing Power Parity
PRIME	Productivity, Rights, Investments, Markets, Ecosystem services
REDD	Reducing Emissions from Deforestation and Degradation
RNRA	Rwanda Natural Resources Authority
SME	Small and Medium Enterprise
TIMO	Timber Investment Management Organizations
UAE	United Arab Emirates
UfM	Union for the Mediterranean
UNCCD	United Nations Convention to Combat Desertification
UNDCPAC	UNEP Desertification Control Programme Activity Centre
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
USD	United States Dollars
USDA-NRCS	United States Department of Agriculture-Natural Resources Conservation Service
WAD	World Atlas of Desertification
WBPCD	World Bank Partnership on Combating Desertification
WFP	World Food Programme
WRI	World Resources Institute
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

Land degradation is the long-term decline of natural productivity and affects up to 75 percent of all land. Land degradation is defined as the reduction or loss of the biological or economic productivity arising from human activities and habitation patterns, such as long-term loss of natural vegetation, affecting all regions and not just drylands. Land degradation is influenced by site-specific contexts, such as soil type, topography, farming practices, and land-use history. Most assessments of land degradation will therefore consider each of these variables separately, making land degradation hard to measure directly. Given the challenges of measuring land degradation, estimates for global land degradation as a percentage of total land area range from 11 percent to 75 percent. About 4.2 million km^2 is degraded annually, with Africa and Asia being the most affected. Land degradation has therefore become an alarming global concern.

More than half of all land and a quarter of arable land in MENA is degraded. Studies on land degradation in MENA over the past two decades reveal overall land degradation of 40 percent to 70 percent. The Normalized Difference Vegetation Index (NDVI) data from 1982 to 2006 indicated that more than 40 percent of the total MENA region was sensitive to land degradation and desertification. Around 45 percent of the total agricultural area is exposed to salinity, soil nutrient depletion, and wind-water erosion, including about 68 percent of the rainfed agricultural land, one-third of the irrigated cropland, and 85 percent of the rangeland. In 2012, an estimated 20 percent of the population lived on these degraded lands, found mostly in the marginal and so-called lagging areas of the MENA region. Poverty rates in these regions typically hover around 50 percent and, regionally, account for an estimated 40 percent of the poor in the region.

Regionally, the Mashreq area suffers from greater land degradation than the rest of MENA.[1] The degree and type of desertification varies from one country to another within the region. The change in vegetation for each country over the past two decades shows that Egypt, Jordan, and Palestine, have as much as 80 percent of their land area experiencing vegetation decline. Over 60 percent of the land in Iraq, Syria, and Tunisia is severely degraded, with over 60 percent of the population living on degraded lands in these countries. Over 60 percent of the population in Jordan, Algeria, and Egypt live on severely degraded lands, even though severely degraded lands make up less than 30 percent of their total land assets. The distribution of population on degraded lands is likely to be a causal

[1]According to the World Bank's definition, the Mashreq countries include Iraq, Jordan, Lebanon, Syria, and West Bank and Gaza. The Maghreb countries include Algeria, Morocco, Tunisia, Libya, and Mauritania.

factor for land degradation as well as an indicator of severity. Land degradation therefore affects countries in MENA disproportionately, with each country experiencing a unique set of drivers and effects from it.

Characteristics of the MENA region, such as hyperaridity, water scarcity, and high population growth, are factors that contribute to and exacerbate land degradation in the region. Approximately 89 percent (or 14.1 million km^2) of MENA is dryland, which is characterized by unpredictable rainfall, specialized soil life, and vulnerability to climate change. Furthermore, drylands are at risk for further degradation, as it is estimated that about 33 percent of global land is vulnerable to desertification. About 60 percent of MENA's land is considered hyperarid. Less than 40 percent of the total land is therefore used for grazing and agriculture, most of which is in arid and semiarid conditions. Arable land, which is scarce in MENA, has declined by about 20 percent since 1994. More than half the countries in MENA are categorized as extremely water stressed, but despite that, the region continues to deplete water resources exceeding renewable freshwater resources. In addition, MENA experienced the highest rate of population growth of any region in the world over the past century. Higher population densities on lands vulnerable to degradation are likely to exacerbate the problem.

Unsustainable land and water management to meet food demands for an increasing population coupled with weak land tenure and instability have also led to land degradation in MENA. Land degradation in Arab countries such as Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Saudi Arabia, United Arab Emirates, and Yemen is primarily caused by rapid population growth and the failure of resource management policies, coupled with overgrazing. Policies encouraging intensive agriculture have led to the widespread clearance of land for mechanized farming under monocultures, the removal of trees, and abandonment of traditional crop rotations and other sustainable management practices. In addition, natural water resources are being rapidly depleted to meet the food demand, with many water scarce countries irrigating with groundwater. Another important driver of land degradation is weak land tenure and ineffective governance over natural resources, particularly in communally managed areas like grasslands and dry forests. Additionally, violent conflicts in the region have caused enormous and massive migration inside these countries, as well as across and beyond the region. Millions of refugees and displaced people have been pushed to abandon their lands, which has led to a contraction in supply through a breakdown in production, the destruction of physical capital, and the dislocation of labor, thus deteriorating both land and economy.

Studies that have monetized costs of land degradation have found relatively higher ecosystem and income losses in MENA than other regions, with land degradation costing an average of 1 percent of GDP. Value of agricultural land, measured by net primary productivity, has most significantly declined for the MENA region in the past 20 years, with about a 50 percent decrease in value. Ecosystem service losses from land degradation in MENA are about four times as much as the global average. The losses are about 5,600 USD per person or about 300,000 USD per km^2 in MENA, compared to the world average of 1,000 USD per person and 50,000 USD per km^2. While there isn't an estimate for income losses for each land type in MENA, degraded rangelands affect both Africa and Asia severely, costing them over 7,000 USD million each year. Degraded irrigated lands affect Asia the most, with about 8,000 million USD loss in income annually, over 5 times that of other continents. On average, land degradation costs MENA countries about 1 percent of their national GDPs, ranging from 0.4 to 2.5 percent. This estimate is

significantly understated as it only considers agricultural yield declines. For most countries, air pollution impacts are as costly or costlier than land degradation, which is also partly driven by land degradation.

Countries in MENA have unique symptoms and costs of land degradation. Reduced yield is usually the largest economic cost of land degradation. For instance, over 40 percent of Syria's irrigated land is affected by soil salinity to varying degrees. About 125,000 hectares suffer from high soil salinity, resulting in a 37 percent decline in yields for main irrigated crops. This translates to a total annual loss of 80 million USD or 0.45 percent of GDP. However, many countries have varying and disproportionate types of land degradation costs. For instance, soil erosion in cereal agricultural systems in Africa cost as much as 127 billion USD a year, or 12 percent of the average GDP of African countries. In addition, agricultural land degradation costs in Morocco are substantial, whereas rangeland and forest degradation costs in Jordan are alarming.

Soil erosion and degradation are some of the costliest forms of land degradation that significantly reduce agricultural yield. As land degradation is synonymous with soil degradation and long-term loss of vegetation, the impact on crop yields is the most noticeable one. Soil and land degradation are interrelated issues and often come up in the same context. Yields of grains and other crops could decrease substantially across MENA as soil further degrades. Soil degradation symptoms such as erosion, compaction, fertility, and salinization are associated with significant losses. Soil erosion could account up to 10 percent of yield reduction losses globally, equivalent to an area of 4.5 million ha per year. Unsustainable agricultural practices have led to soil compaction, which also negatively impacts agricultural yield. It has caused yield reductions of 25 to 50 percent in some regions of Europe and North America, and between 40 and 90 percent in West African countries. Land degradation also results in a decline in soil fertility, which has had huge economic costs. For instance, in South Asia the annual economic loss is estimated at 600 million USD for nutrient loss by erosion, and 1,200 million USD due to soil fertility depletion. Another form of soil degradation is salinization, where about 20 percent of irrigated cropland has salt-induced yield declines causing an estimated economic loss of 27.3 billion USD.

Land degradation has many other wide-ranging impacts that are hard to monetize, such as impacts on poverty, sand and dust storms, health, and ecosystems. Land degradation generally means that less food is produced on the land, which has a direct impact on the health and well-being of inhabitants. Among all world regions, MENA is the only region that experienced an increase in the proportion of undernourished people over the past decade. Food insecurity, along with increased prices and increased disaster risks, also leads to high poverty rates. Sand and dust storms are also linked to land degradation, which is a significant problem in the MENA region. They in turn impact health, agriculture, and infrastructure where a single storm can cost over hundreds of millions of USD. These processes and impacts are discussed in further detail in the complementary report titled *'Sand and Dust Storms in the Middle East and North Africa (MENA) Region—Sources, Costs, and Solutions'*. While climate change can drive land degradation, land use and land degradation can also significantly contribute towards climate change. Cultivation of crops, livestock management, deforestation, and other land-use changes are substantial contributors of human-induced Green House Gas (GHG) emissions, accounting for 24 percent of 2010 global GHG emissions. Ecosystems are also negatively impacted by land degradation, in the forms of wildlife extinction, and habitat and biodiversity declines in forests, rangelands, and wetlands. Land degradation has also become a significant driver of displacement and reduced cultural values of drylands.

Every dollar spent on restoration can generate as much as 30 USD in economic benefits. Just as land degradation has costs that go beyond just agricultural yield and income, restoration has many benefits that range from job creation to increase in biodiversity. Restoration also stimulates job creation and economic growth. Restoring 150 million hectares of degraded agricultural land could generate 85 billion USD in net benefits to national and local economies, provide 30–40 billion USD a year in extra income for farmers, and provide food for an additional 200 million people. In the USA for example, restoration investment has resulted in the direct employment of 126,000 workers, which generates 9.5 billion USD in economic output annually. Studies estimate that every dollar spent on restoring degraded forests yields between 7 to 30 USD in economic benefits. Failure to incorporate all the benefits of restoration leads to a much lower estimate of $0.7 trillion USD in net benefits and reduces the attractiveness of investing in it.

Recently, several projects and initiatives have been introduced to address land degradation in MENA. The MENA region, which is one of the regions most affected by desertification, has recently started making some progress toward land restoration. Over the past two decades, some initiatives and projects, ranging in scale and thematic coverage, have addressed land degradation in MENA. Several programs and projects have been completed or are ongoing in the MENA region that focus on forest and agricultural land restoration. The projects range from multicountry and long-term initiatives such as the Great Green Wall to smaller initiatives such as Acacias for All in Tunisia. Some of these are described in more detail to present the range and scale of different efforts in the region. These success stories show that concerted efforts can indeed stop and even reverse desertification.

Undervalued benefits, inaccessible and small government funds, and lack of incentives for the private sector to invest are some of main reasons restoration is lacking. Investments to restore degraded lands are generally lacking due to the undervalued and longer term benefits of restoration. It is estimated that approximately 350 billion USD is needed for conservation and restoration, but only 50 billion USD is available, and 80 percent of that comes from public sources. Private investment is only about 10 billion USD a year. Financial systems must internalize the environmental and social costs of restoration projects to allow for restoration to be financed at scale. From the sources that are available, there also barriers that prevent restoration financing. In terms of public finance, barriers include small environmental budgets and inaccessibility to climate finance. For instance, public climate finance totaled 128 billion USD in 2012, where land-use projects accounted for just 7 billion USD of that total, and only a fraction of that was for restoration. Another issue is that while governments have funded restoration projects, the money often comes from small environmental budgets. Private restoration financing is lacking because most restoration projects are too small or require a long investment time horizon and have many risks associated. Capital is usually concentrated in large funds, so a 5 billion USD fund has less incentive in making a 5 million USD investment because of transactions costs. Given a high discount rate and a back-loaded cash flow profile, restoration investments are often viewed by private investors as having poor risk-adjusted returns.

Besides barriers for investments, there are also lessons learned from restoration projects in MENA that are important to consider for future interventions to work. There are several conditions for actions to be successful in terms of fostering adoption of more sustainable land management: the cultural, economic, financial, legal, political, social, and technical environment all need to be aligned to ensure that one or several complementary options can be implemented successfully. In addition, there are some beneficiary-level lessons that should be addressed in restoration projects. One of the biggest lessons learned from projects already implemented is that they have often been too top-down

in their approach. Local participation in project planning and implementation is important because previous attempts to combat desertification failed to consider the views, perceptions, and capacities of local people. Some other challenges include inclusivity, training, and information, and monitoring of community-based land management. More attention should be given to marginalized groups such as women and the landless poor. Additionally, although experience has shown that local institutions can be successful in managing forests, community members need to be provided with adequate training and information, property rights, and autonomy to make financial decisions. Lastly, in terms of interventions, factors that were often ignored or needed improvement had to do with financing and market access.

Adopting the P.R.I.M.E. framework during project design can ensure that land-related constraints are addressed when restoring land and reducing poverty. Land degradation issues are difficult to address without also addressing the needs of households who live on those lands. Many projects focus on sustainable land management practices that can increase productivity so that land is restored and beneficiaries see an increase in income. But, to achieve both those outcomes, some other factors need to be addressed as well. For instance, some of the most common challenges and lessons learned from restoration projects in MENA have to do with land rights, and financial and market access. Ignoring these factors can result in project outcomes being unsuccessful and unsustainable. P.R.I.M.E. is a broad framework that conceptualizes how forests, or land in general, can contribute to poverty reduction. The P.R.I.M.E. framework proposes fives pathways for prosperity, which are increasing productivity of land and labor (P); strengthened rights over land (R); complementary investments in infrastructure and institutions to reduce poverty (I); increased market access (M); and mechanisms that enable the flow of land-based ecosystem services to those dependent on it (E). Addressing all or some of these constraints can help in meeting the goals of restoration and poverty reduction.

The average land restoration project in MENA covered about two to three PRIME themes, which were mostly productivity (P), and complementary investments (I), with very few addressing markets (M). About 44 percent of the projects on land restoration in MENA covered three PRIME themes, with most of the others covering between two or four themes. No projects covered all five themes. Since the PRIME themes are interrelated, it is expected that most projects would address more than one theme. For instance, projects that mainly focus on increasing productivity will also allocate funds on improving infrastructure and information access, which are complementary investments (I). The theme addressed the least in projects was markets (M), which was only addressed in 20 percent of the projects. The results point to a gap in investment in the other three themes—rights, ecosystem services, and especially markets.

Restoration efforts in MENA can be modeled after successful projects from different parts of the world. Over the past few decades, countries all over the world have taken serious measures against land degradation, where some of them have proven to be model restoration projects and/or have offered important lessons. Some of these model projects include rehabilitation efforts after the USA dust bowl; Korea's national deforestation program; China's Great Green Wall; restoration in Tanzania's Shinyanga region; the Loess Plateau watershed rehabilitation project; Ethiopia's Tigray region agriculture development; and restoration of the Brazilian Atlantic rain forest. These projects range in scale and type of land restored and are quite different from each other. However, some similarities are that they adopted a holistic approach to restoration targeting both human well-being and ecosystem functioning; tailored interventions to drivers of degradation; and engaged the community and other stakeholders.

Success factors included significant government buy-in, a range of investors, clear motivation, and other enabling conditions. Four out of the seven initiatives discussed have mainly been funded by the country's federal government. While government funding is usually limited, in these cases the problem and benefits from restoration were significant enough for massive government funding. Second, some of the projects obtained financing from multiple sources such as the government, international donors, and the private sector. Besides funding, other themes for successful restoration were: (i) a clear motivation: decision makers, landowners and/or citizens were motivated to restore land; (ii) enabling conditions in place: enough ecological, market, policy, social, and/or institutional conditions were in place to create a favorable context for restoration; and (iii) capacity and resources for sustained implementation: capacity and resources existed and were mobilized to implement restoration on a sustained basis on the ground.

In addition to lessons learned from other projects, the MENA region has unique factors, such as its dry climate, conflict conditions, extent of land degradation, and its drivers, that must be factored in project design. The MENA region mostly consists of drylands, so interventions must consider drought conditions. As about 60 percent of MENA's land is considered hyperarid, less than 40 percent of the total land is used for grazing and agriculture, most of which is in arid and semi-arid conditions. Another unique factor is that compared to other regions in the world, many countries in MENA are suffering from fragility, conflict, and violence that should be factored in when designing restoration projects. Projects must aim to not escalate any conflict, be considerate of violent pockets, and ensure that interventions are sustained despite ongoing conflict. In addition to unfavorable climate and conflict, MENA also has a relatively large amount of degraded land. Most of the land that is degraded suffers from irreversible degradation with some parts that are less degraded and could be restored. Additionally, some of the land is also vulnerable to desertification. Hence, different types of financing scales and sources should be pursued depending on the extent and severity of degradation. Lastly, drivers of degradation are important to address, which in MENA's case are unsustainable farming, overgrazing, groundwater depletion, and weak land tenure and institutions, among others.

A range of agriculture, livestock, and water management strategies can prevent and restore degraded land in MENA. Integrated crop, livestock, and forest is a proven approach to sustainable land management in the drylands. Perennials and cattle can be incorporated into traditional row-crop production systems, also known as sustainable intensification. Adoption of conservation agriculture can be an effective preventive and mitigating strategy for addressing cropland degradation. Conservation agriculture is applicable to all agricultural landscapes as it emphasizes the use of local knowledge and native biological processes. No or low-till agriculture is a form of conservation agriculture which can also restore degraded lands in drylands. For rangeland, the use of local customs and technology for rangeland planning can be very effective in restoring land. The most widespread land use in drylands is extensive livestock production or pastoralism. Developing and implementing grazing management plans are effective responses to avoid and reduce rangeland degradation at sensitive parts, such as slopes, water points, and riparian strips. Further, livestock and crop composition can be changed or managed according to the geographical and climatic conditions. For water management, small-scale irrigation and the use of freshwater substitutes such as brackish and wastewater have a lot of potential in reducing agricultural water scarcity in MENA. Besides irrigation, crops and cropping systems can also be engineered to become more water efficient. For instance, salt-tolerant species for brackish-water irrigation, and drought-tolerant crops should be planted.

For implementing technical interventions, funding sources must be identified, and strategies to overcome financial barriers must be identified first. First and foremost, an appropriate funding source and funding instrument must be identified to finance restoration. Depending on the nature and scale of the restoration activity, options for sources include investments by the private sector into community development; local up to national government resources; foreign direct investment; and grants from charities, foundations, philanthropists, international donors and supranational organizations such as the World Bank or the Global Environment Facility (GEF). Besides identifying a source, restoration also faces a huge financing gap due to systematic, public, and private finance barriers, but there are some strategies that can facilitate financial flows. First, carbon taxes could be imposed where some of its revenue could fund restoration. Another similar strategy is to leverage climate finance for restoration. Restoration should be acknowledged as a part of climate mitigation and adaptation strategy. Third, governments should also reform their current incentive systems (such as agricultural subsidies) which currently make it profitable to degrade land. Lastly, projects can also be bundled as it decreases risks, increases investment size, and increases liquidity, which is more attractive to private investors

Other enabling conditions such as collaboration, institutional capacity, community participation, and P.R.I.M.E. constraints must also be addressed for restoration to be successful. Supportive political environment and institutional capacity play important roles in the success of projects aimed at combating desertification. Stakeholders in land management need to work together more effectively at a local and regional level. So, collaboration between the government, research institutions, nongovernmental organizations (NGOs), the private sector, and community organizations should be enabled. In addition, when designing responses to land degradation drivers or processes, local knowledge and customary practices should be given a high priority. Community or indigenous knowledge-based approaches have been proven effective in restoring degraded land and conserving soils and water in many parts of the world. It is important to recognize that customary practices adopted by local people have significance in halting land degradation. Interventions should also address P.R.I.M.E. pathways out of poverty so that poverty is addressed along with land degradation. Productivity enhancing interventions are usually the norm, however equally important is to secure land rights, strengthen complementary institutions, enable market access, and increase the benefits from ecosystem services through mechanisms such as Payments for Ecosystem Services.

INTRODUCTION

Land management in the Middle East and North Africa region (MENA)[2] is facing important challenges with degradation and needs to learn from others in order to make progress at scale. Sustainable land management and the restoration of degraded lands are important topics in the Middle East and North Africa (MENA) region, not only because of the significant role that land plays in people's livelihoods, but because of its sensitivity to changes in its management and to the impacts of climate change. Poorly-managed land can lead to soil productivity losses and even well-managed land needs to adapt to the changing climate. Because of these complex relationships with land, it is important to draw lessons from previous experience and innovate beyond the traditional approaches to restore degraded lands—and at scale.

The objective of this report is to provide the evidence base for governments and policymakers in developing a regional program on land restoration in MENA, drawing on lessons from Africa and other regions with large-scale efforts. The literature on sustainable land management and restoration of degraded lands is vast. This report reviews relevant global and regional experience and develops an applicable framework for MENA countries (i.e., through the PRIME framework). It reviews the costs and impacts of land degradation and how different land management approaches can be used to halt or reverse degradation. It advocates for a regional approach, since the management in any one area may influence the livelihoods in another—through the transboundary nature of land management (e.g., degraded lands can lead to an increase in the frequency or intensity of sand and dust storms, and affecting human health in other areas). Finally, the financing of land restoration needs to create incentives for greater private sector participation, so that it has greater geographical reach and at a scale that makes a difference.

[2]According to the World Bank definition, the Middle East and North Africa (MENA) region includes 19 countries, which are—Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates (UAE), West Bank and Gaza, and Yemen.

LAND DEGRADATION IN THE MIDDLE EAST AND NORTH AFRICA (MENA) REGION[3]

GLOBAL LAND DEGRADATION AND DESERTIFICATION

Land degradation has recently been highlighted as a global concern. The UN Convention to Combat Desertification (UNCCD, 1994: Part I, Article 1, F) stated that: "land degradation means reduction or loss, in arid, semiarid and dry sub-humid areas, of the biological or economic productivity arising from human activities and habitation patterns such as long-term loss of natural vegetation."[4] However, the World Atlas of Desertification, 2018 (WAD3) uses a more expansive definition of land degradation as given by the Millennium Ecosystem Assessment: "land degradation leads to a long-term failure to balance demand for and supply of ecosystem goods and services."[5] They assert that land degradation affects all regions, not just drylands.

While experts agree on the definition of land degradation, measuring it is not straightforward. Over the years, many studies have estimated the extent of degradation using one or a combination of proxies, which results in a widely differing range of estimates (Table 1). Land degradation is influenced by site-specific contexts, such as soil type, topography, farming practices, and land-use history. Most assessments of land degradation will therefore consider each of these variables separately, making land degradation hard to measure directly. Studies mainly rely on proxies in the form of satellite-derived indices, expert opinion, agriculture abandonment, or modeling.[6] Additionally, researchers often use different terminology to define and categorize the severity of land degradation. Data availability and resource constraints also mean that not all areas are covered in these analyses. Therefore, differences in terminology, approach, and areas covered lead to differing degradation estimates.

[3]According to the World Bank definition, the Middle East and North Africa (MENA) region includes 19 countries, which are—Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates (UAE), West Bank and Gaza, and Yemen.
[4]UNCCD, "United Nations Convention to Combat Desertification," 1994.
[5]Cherlet et al., World Atlas of Desertification.
[6]Gibbs and Salmon, "Mapping the World's Degraded Lands."

TABLE 1: GLOBAL LAND DEGRADATION ESTIMATES FROM PUBLISHED STUDIES[7]

Percentage of Total Land Area Degraded	Source
22.5	International Soil Reference and Information Centre, 1990
16	United Nations Environment Program, 1996
66	Food and Agriculture Organization, 2000
11	Land Availability for Biofuel Production (Cai, X., X. Zhang, D. Wang, 2011)
29	Food and Agriculture Organization, 2011
15	International Institute of Applied Systems Analysis & Food and Agricultural Organization, 2012
29	Biomass Productivity-based Mapping of Global Land Degradation Hotspots (Le, Q. B., Nkonya, E., and Mirzabaev, A., 2014)
75	World Atlas of Desertification by the Joint Research Centre, 2018

Latest estimates reveal that over 75 percent of the Earth's land area is already degraded. Given the challenges of measuring land degradation, estimates for global land degradation as a percentage of total land area range from 11 percent to 75 percent. According to the latest land degradation assessment atlas published by the Joint Research Centre (JRC), about 75 percent of the world's lands are already degraded and over 90 percent could become degraded by 2050. The study estimates that about 4.2 million km^2 is degraded annually, with Africa and Asia being the most affected. They also predict that land degradation could lead to a loss of 10 percent of global crop yields by 2050. The atlas provides the first comprehensive, evidence-based assessment of land degradation at a global level and highlights the urgency to adopt corrective measures (Box 1).

Desertification is human-induced land degradation in drylands. The term desertification is usually associated with an image of an advancing desert, with grazing and arable lands turning into deserts. Desertification is land degradation in arid, semiarid and dry areas resulting mainly from human impact. It can range in severity from slight to very severe and can be driven by many factors, such as erosion, salinization, and chemical accumulation, irrespective of climate. These processes mainly affect irrigated cropland, rainfed cropland, rangelands, and woodlands. However, desertification can be hard to differentiate from droughts which have similar impacts. In the 1970s and 1980s droughts in the Sahel highlighted a phenomenon common throughout drylands where bad management during droughts leads to long-term land degradation. Another example is the Dust Bowl days of the 1930s in the Great Plains of the USA where soil erosion was triggered by extreme drought. That period also coincided with unsuitable agriculture practices into marginal lands which affected wheat production and cattle numbers.[8, 9]

Most of the land in MENA is degraded, and the rest is highly vulnerable to further desertification. Approximately 89 percent (or 14.1 million km^2) of MENA is dryland, which is characterized by unpredictable rainfall, specialized soil life, and vulnerability to climate change. Due to these characteristics, land degradation in the drylands is both

[7]Some of the estimates above have been converted to percentage terms using 9 billion hectares as the total area. The Earth has a total of 12.9 billion hectares of land area. Given that 71% of the total land area is habitable/productive, the estimates above consider percentage degraded out of 9 billion hectares of total land. When results were reported in percentage of dryland area, the estimate was adjusted for total land assuming that drylands make up 41% of the total land area.
[8]Egan, The Worst Hard Time: The Untold Story of Those Who Survived the Great American Dust Bowl.
[9]Graetz, "Desertification: A Tale of Two Feedbacks."

BOX 1: WORLD ATLAS OF DESERTIFICATION, 2018

On 21 June 2018, the JRC published a new edition of the World Atlas of Desertification, offering a tool for decision makers to improve local responses to soil loss and land degradation. The Atlas provides the first comprehensive, evidence-based assessment of land degradation at a global level and highlights the urgency to adopt corrective measures.

This third edition of the World Atlas of Desertification focuses on land degradation and global environmental change under five major subject headings:

Global Patterns of Human Domination. Highlighting the role of Homo sapiens as the major driving force of global environmental change;

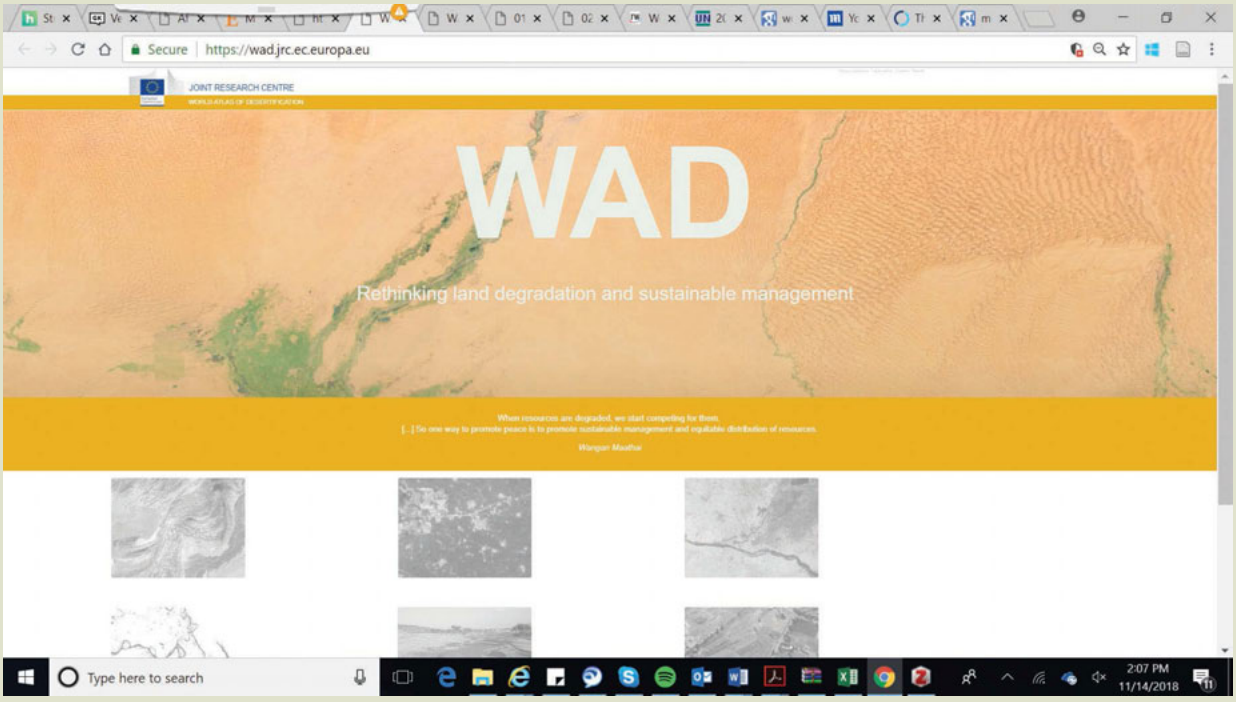
Feeding a Growing Global Population. The ability to feed 10–12 billion humans by the end of the century is one of the great challenges facing humanity, creating enormous burdens on the land;

Limits to Sustainability. The Brundtland Commission defined sustainable development as "development which meets the needs of the present, without compromising the ability of future generations to meet their own needs." There are numerous obstacles that must be overcome to achieve this goal;

Convergence of Evidence. Many of the anthropogenic induced environmental changes can be measured and their combined effects are indicative of the multiple stresses humans exert on the land. WAD3 draws on this complexity by adopting the concept that evidence or signals from multiple sources may "converge," thus leading to the development of testable hypotheses and/or conclusions that are supported by data. Convergence of evidence maps replace the 'maps of desertification' of WAD1–WAD2; and

Solutions. Potential solutions to land degradation need to be identified and implemented within the context of local social, economic, and political conditions.

Accompanying this atlas is a web-based platform that enables independent interrogation and analysis. WAD3 seeks to advance a dynamic, interactive set of global data and analytical tools that can be continuously expanded and updated, to produce custom-configured products to meet the divergent needs of users. The webpage will be gradually upgraded and improved. The web-based platform can be accessed at http://wad.jrc.ec.europa.eu/



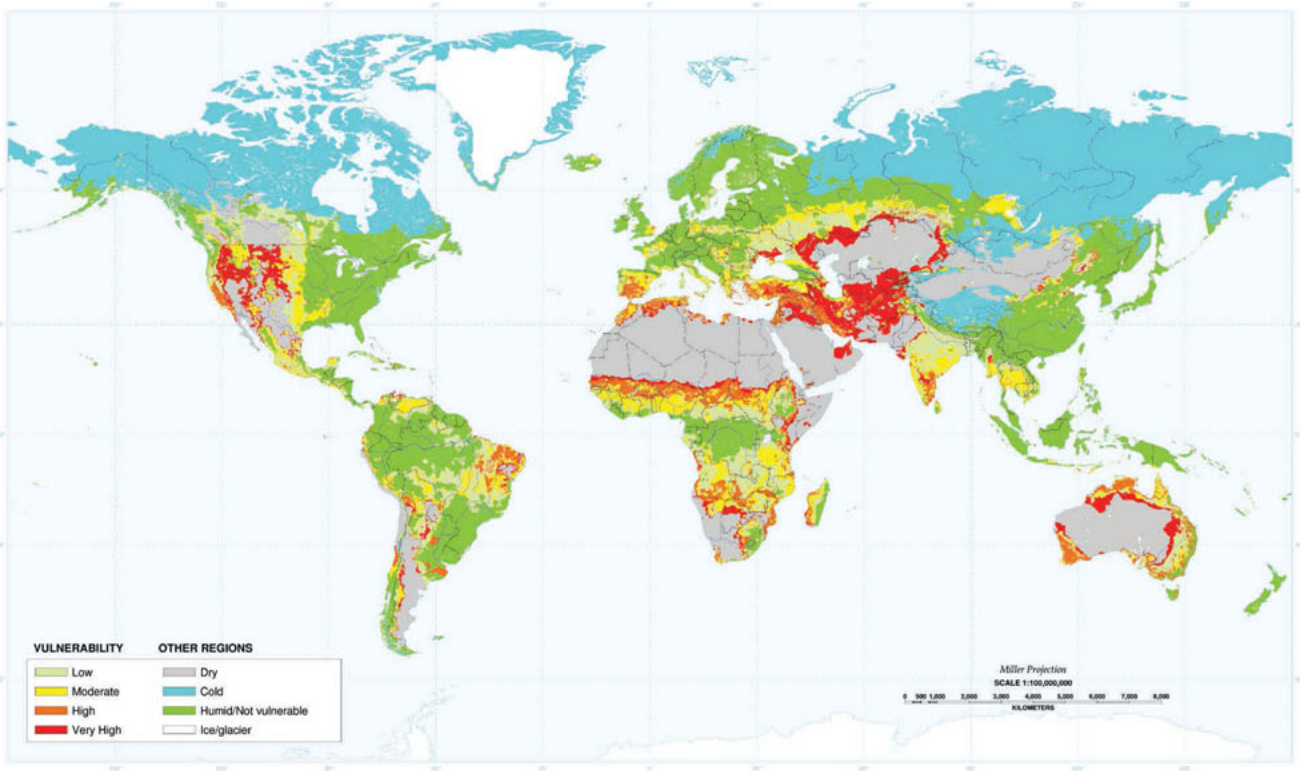
more serious and harder to reverse. Table 2 provides continental estimates of land degradation from various studies until 2011. These estimates are vastly different from JRC's 4.2 million km^2 global estimate of degradation due to difference in methodology, data, and most importantly, the years these studies were conducted. However, these studies provide relative estimates which show the extent of degradation in Asia and Africa compared to other continents. Unsurprisingly, the two continents have much more degraded land than other regions, ranging from 10,000 to 250,000 hectares depending on the study and methodology used. Furthermore, drylands are at risk for further degradation as it is estimated that about 33 percent of global land is vulnerable to desertification.[10] Many MENA countries have land that is either already desertified or at high risk for desertification (Figure 1).

TABLE 2: CONTINENTAL ESTIMATES OF DEGRADATION (ha 100)

Area	GLASOD (Olderman et al., 1990)	FAO TerraSTAT (FAO, 2002)	Dregne & Chou (1992)	GLADA (Bai et al., 2008)	Cai et al. (2011)	Campbell et al. (2008)
Africa	321	1,222	1,046	660	132	69
Asia	453	2,501	1,342	912	490	118
Australia	6	368	376	236	13	74
Europe	158	403	94	65	104	60
North America	140	796	429	469	96	79
South America	139	851	306	398	156	69
World (Total)	1,216	6,140	3,592	2,740	991	470

Source: Gibbs and Salmon (2015).[11]

FIGURE 1: DESERTIFICATION VULNERABILITY



Source: USDA-NRCS, 1998.

[10]Dregne and Chou, "Global Desertification Dimensions and Costs."
[11]Gibbs and Salmon, "Mapping the World's Degraded Lands."

EXTENT OF LAND DEGRADATION IN MENA

More than half of all land and a quarter of arable land in MENA is degraded. Studies on land degradation in MENA over the past two decades reveal overall land degradation of 40 percent to 70 percent (Table 3).[12] Arable land is roughly 14.5 percent (or 2 million km^2) of the total area. 553,000 km^2 of the vegetation has degraded in these areas, meaning that roughly one in four hectares (27 percent) of arable land have degraded between 1999 and 2012. In 2012, an estimated 20 percent of the population lived on these degraded lands, found mostly in the marginal and so-called lagging areas of the MENA region. Poverty rates in these regions typically hover around 50 percent and, regionally, account for an estimated 40 percent of the poor in the region.

TABLE 3: MENA DEGRADATION ESTIMATES FROM PUBLISHED STUDIES

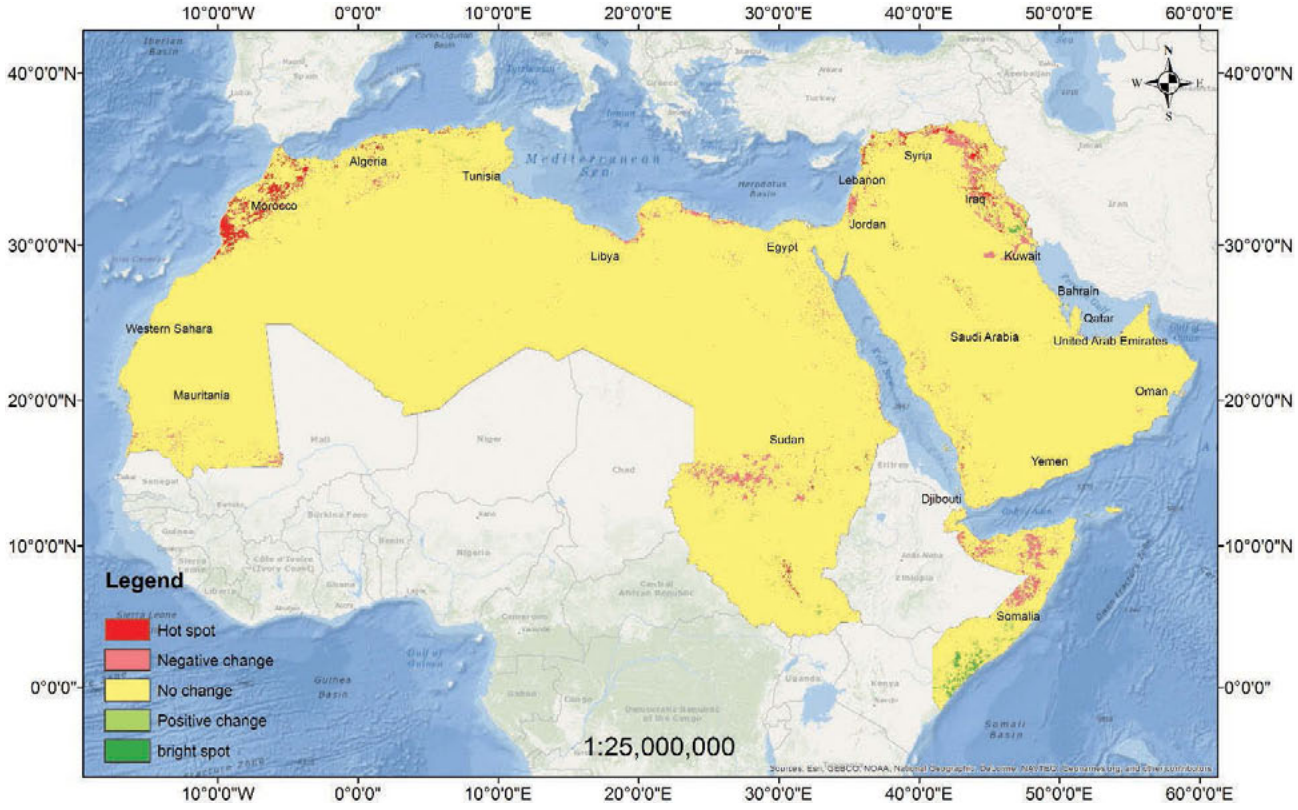
Percentage of Total Land Area Degraded	Source
45	Lal, 2002
20	United Nation's Arab Human Development Report, 2009
70	Arab Centre for the Study of Arid Zones and Drylands, 2013
45	Food and Agriculture Organization, 2015
40	United Nation's Environment Program, 2016

The MENA region experienced a 40 percent decrease in vegetation over the past two decades, with some countries experiencing a very significant decline. The Normalized Difference Vegetation Index (NDVI) is the most widely used indicator of land degradation.[13] Analyzing NDVI data over multiple time periods allows for the assessment of long-term changes in land degradation and desertification vulnerability. NDVI data from 1982 to 2006 indicated that more than 40 percent of the total MENA region was sensitive to land degradation and desertification (Figure 2).[14] In contrast, only less than 5 percent of the region had witnessed positive changes in vegetation cover. Specifically, the analysis shows a critical increase in land degradation in northern African countries, especially along the coastline extending from Morocco to Egypt, and the upper Arabian Peninsula containing Syria and Iraq.

Most of the region is affected by severe to very severe desertification. About 6 percent of the region's land area is slightly desertified, 21 percent is moderately desertified, 31 percent is severely desertified, and 11 percent is very severely desertified. Soil erosion, salinization of agricultural land, dust storms, and active sand dunes have significantly increased in the region, in turn giving rise to increased desertification. Around 45 percent of the total agricultural area is exposed to salinity, soil nutrient depletion, and wind-water erosion, including about 68 percent of the rainfed agricultural land, 33 percent of the irrigated cropland, and 85 percent of the rangeland.[15]

[12]A wide range is provided given the challenges with land degradation measurement discussed above. Additionally, studies also use different sets of countries in their analyses, usually due to data availability.
[13]The NDVI is a simple graphical indicator that can be used to analyze remote sensing measurements, typically, but not necessarily, from a space platform, and assess whether the target being observed contains live green vegetation or not.
[14]Faour, "Detection and Mapping of Long-Term Land Degradation and Desertification in Arab Region Using MODESERT."
[15]AOAD, "Arab Agricultural Statistics Yearbook. Arab Organization for Agricultural Development, Khartoum."

FIGURE 2: VEGETATION CHANGES IN MENA OVER 1982–2006

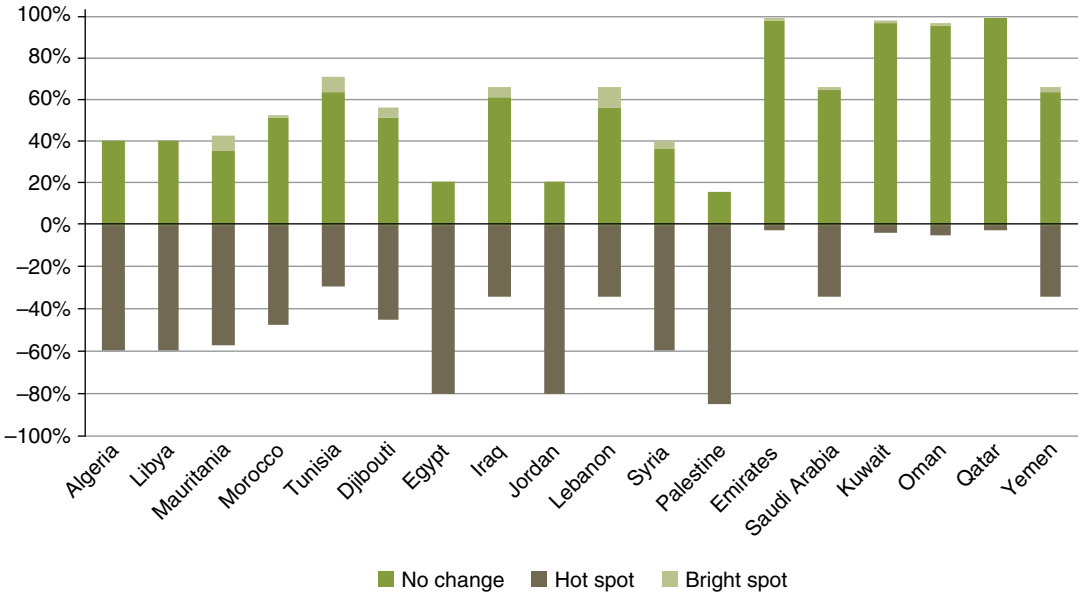


Source: Faour, 2014.

Regionally, the Mashreq area suffers from land degradation relatively more than the rest of MENA. The degree and type of desertification varies from one country to another within the region. The change in vegetation for each country over the past two decades was analyzed, where lands were either classified as hot spots (negative change in vegetation), no change, or bright spots (positive change in vegetation). Countries with the most significant proportion of hot spots are Egypt, Jordan, and Palestine as about 80 percent of their land area experienced vegetation decreases (Figure 3). Another study classified land as severely, moderately, and lightly degraded and the percentage of population that lives on each kind of land. Over 60 percent of the land in Iraq, Syria, and Tunisia is severely degraded, with over 60 percent of the population living on degraded lands in these countries (Figure 4 and Figure 5). Over 60 percent of the population in Jordan, Algeria, and Egypt live on severely degraded lands, even though severely degraded lands make up less than 30 percent of their land. The distribution of population on degraded lands is likely a causal factor for land degradation as well as an indicator of severity. Land degradation therefore affects countries in MENA disproportionately, with each country experiencing unique set of drivers and effects from it.

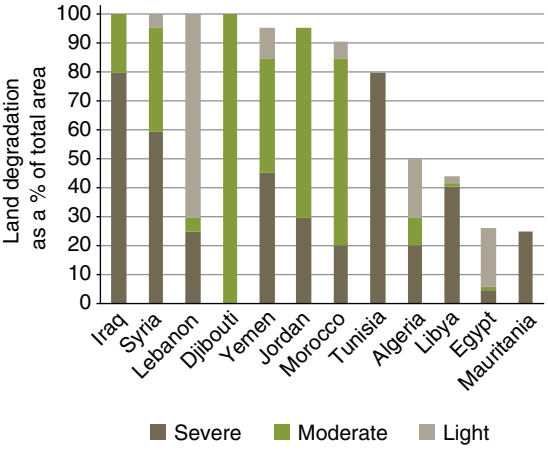
The information base on the current magnitude of desertification in the MENA region is very poor, but proxies and available data still flag a major desertification problem. Despite the impact of land degradation and desertification on the environment and the sustainability of life, estimates of land degradation are generally presented in separate contexts. It remains difficult to present the extent and severity of land degradation in a single framework for a regional scale. So far, most research on the

FIGURE 3: HOT SPOTS, BRIGHT SPOTS, AND NO CHANGE IN VEGETATION IN MENA FROM 1982 TO 2006



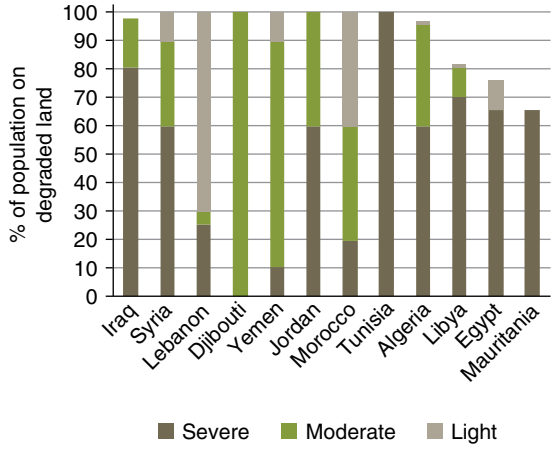
Source: Faour, 2014.

FIGURE 4: HUMAN INDUCED LAND DEGRADATION



Source: Larsen, 2011.

FIGURE 5: POPULATION DISTRIBUTION ON DEGRADED LANDS



Source: Larsen, 2011.

status of land degradation has involved local investigations for the exploration of specific driving forces. Other research has focused on investigating vegetation dynamics as they are considered the key components for the understanding of land surface models, especially when assessing and monitoring land degradation and desertification. For most of Africa, and particularly for the African part of the MENA region, very little is known about the extent of land degradation. Even though estimating land degradation is hard, there are still data available on vegetation productivity and other indicators of degradation. These indicators are good proxies for land degradation, and while they do not provide a precise land degradation measure, they still contribute significantly to the discussion.

DRIVERS OF LAND DEGRADATION

Land degradation is caused by both natural and anthropogenic direct drivers, which are in turn shaped by indirect drivers. Land degradation can arise because of inherent natural processes and extreme events. However, these events can be exacerbated by anthropogenic actions, as in the case of landslides that result from road building or pest outbreaks that arise following their introductions to new habitats by humans. The impacts of natural drivers are also intensified by human-induced climate change. Globally, the most widespread drivers of land degradation are those that are directly linked to human practices. Indirect drivers are the ultimate underlying causes of land degradation, as they arise from the way societies function and are external from the ecosystem. Table 4 provides a comprehensive list of direct and indirect drivers that lead to land degradation in general, ranging from direct human drivers like soil management to indirect drivers such as urbanization and industrialization.[16]

TABLE 4: DIRECT AND INDIRECT DRIVERS OF LAND DEGRADATION

Direct	
Driver	**Examples**
Grazing land management	Change in the extent of grazing lands, livestock type, stocking rates, rotation regimes, supplementary feeding, irrigation and water management, pasture improvement
Croplands and agroforestry management	Change in extent of croplands and agroforestry systems, crop type, crop rotation, soil management, harvesting and fallow cycles, agricultural inputs, irrigation
Forests and tree plantation management	Change in the extent of managed and planted forests, harvesting intensity, rotation regimes, silvicultural techniques
Non-timber natural resource extraction	Fuelwood harvesting, hunting, harvesting of wild foods, fodder, medicinal and other products
Fire regime changes	Changes in frequency, intensity, season and timing of fire, including fire suppression
Extractive industry development	Mine type, extraction and refining techniques, pollutant discharge and spoil disposal, reclamation, spatial planning
Infrastructure and industrial development and urbanization	Land clearance, dams and hydroelectric power plants, roads and railways, other infrastructure development, irrigation
Indirect	
Demographic	Population growth rate, migration and population mobility (including to urban centers), density, age structure
Economic	Demand and consumption, poverty, commercialization and trade, urbanization, industrialization, labor markets, prices, finance
Science, knowledge, and technology	Education, indigenous and local knowledge, taboos, research and development investments, access to technology, innovation, communication and outreach
Institutions and governance	Public policy (regulatory and incentive based), property rights, customary law, certification, international agreements and conventions (trade, environment, and so on), competencies of formal institutions, informal institutions (social capital)
Cultural	Worldviews, values, religion, consumer behavior, diet

Source: Montanarella et al., 2018.[16]

[16]Montanarella, Scholes, and Brainich, "The IPBES Assessment Report on Land Degradation and Restoration."

The drivers of degradation in MENA are mainly poor land management but also climatic. Many interrelated factors contribute to desertification, including population growth, demands for greater levels of production, technologies that increase resource exploitation, and climate change. In addition, desertification is also happening due to intensive management practices, which are often associated with a misunderstanding of dryland ecology. While land degradation has numerous drivers, there are some that are particularly prominent in MENA. Existing natural hazards contribute further to land degradation and desertification in the MENA region. Extreme temperatures, wildfires, flooding, landslides, and sand and dust storms are also among the natural events that are both a cause and an effect of degradation. While traditional agricultural approaches may no longer be enough to meet rising demand, they are also being replaced by more damaging alternatives.

NATURAL CHARACTERISTICS OF MENA

A majority of the MENA area is hyperarid and has lost a lot of its arable land. Arid and semiarid areas amount to about 89 percent of the MENA region. Five north African countries (Egypt, Libya, Tunisia, Algeria, and Morocco) and twelve Middle Eastern counties (Bahrain, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, the United Arab Emirates, and Yemen) lie in arid areas.[17] The most common features of arid and semiarid lands in MENA are erratic and low rainfall; higher evapotranspiration than rainfall; water-constrained agricultural production; and fluctuating temperatures. However, about 60 percent of MENA's land is considered hyperarid. Less than 40 percent of the total land is therefore used for grazing and agriculture, most of which is in arid and semiarid conditions (Table 5). Arable land, which is scarce in MENA, has declined by about 20 percent since 1994, with Palestine and Lebanon losing relatively more arable land than other countries (Figure 6). Cultivated area has also generally declined since then, however some countries such as Egypt, Qatar, and UAE saw an increase in cultivated areas, greater than respective changes in arable land.

TABLE 5: ESTIMATED LAND USE IN MENA

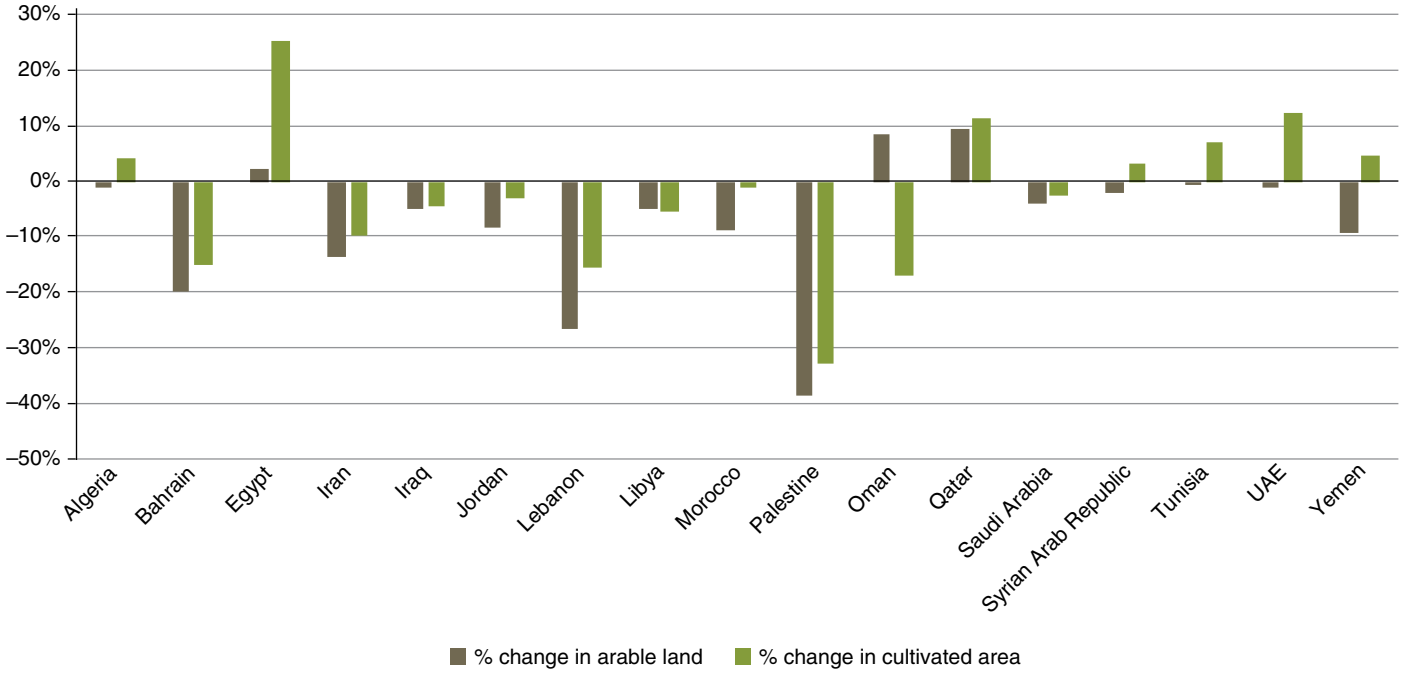
Land Use	Area (1000s of ha)	Percent
Irrigated agriculture	7,372	0.77
Rainfed cropland	29,981	3.12
Rangeland	330,663	34.37
Hyperarid land	593,866	61.74
Total drylands	961,852	100.00

Source: Dregne and Chou 1992; UNEP 1996.

Despite MENA being one of the most water-stressed regions in the world, the region continues to deplete water resources, exceeding renewable freshwater resources. Most countries in MENA are experiencing water scarcity combined with low water use efficiency in agriculture. Fifteen out of 17 MENA countries are considered water stressed (per capita water availability below 1700 cm^3), and 11 out of 17 countries face extreme water scarcity (per capita water availability below 500 cm^3) (Figure 7). Bahrain, Kuwait, Qatar, Saudi Arabia, and UAE are the most water stressed countries. This is likely because the region is characterized mostly of hyperarid conditions coupled with rapid

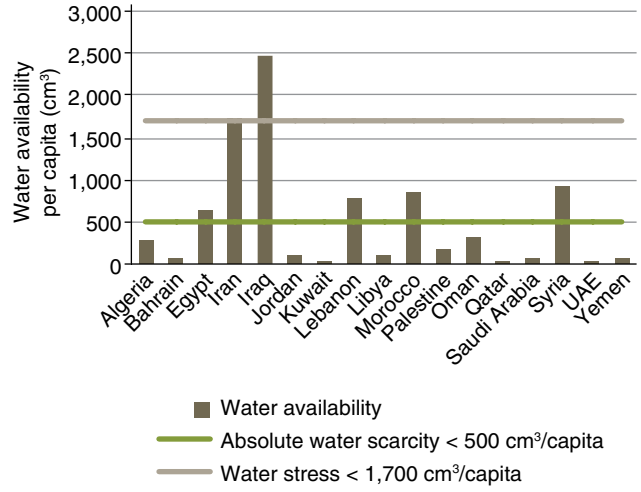
[17]Faour, "Detection and Mapping of Long-Term Land Degradation and Desertification in Arab Region Using MODESERT."

FIGURE 6: CHANGE IN ARABLE LAND AND CULTIVATED AREA FROM 1994 TO 2014



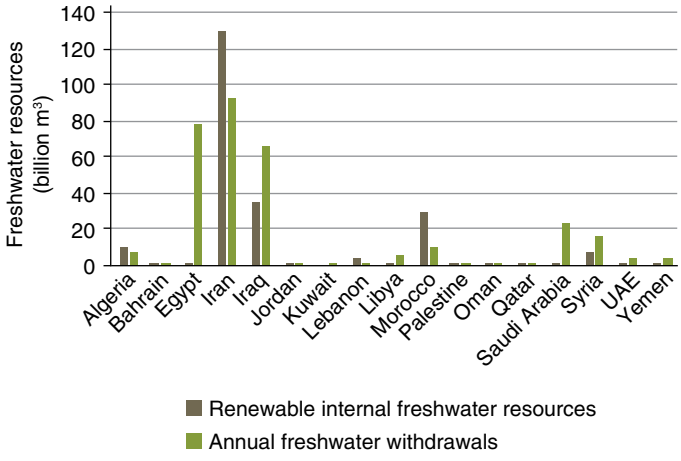
Source: FAO Aquastat, 2014.

FIGURE 7: WATER AVAILABILITY PER CAPITA IN MENA, 2013–2017



Source: FAO, 2018.[18]

FIGURE 8: RENEWABLE WATER RESOURCES AND WITHDRAWALS IN MENA, 2014



Source: World Bank, 2018; FAO, 2018.[19]

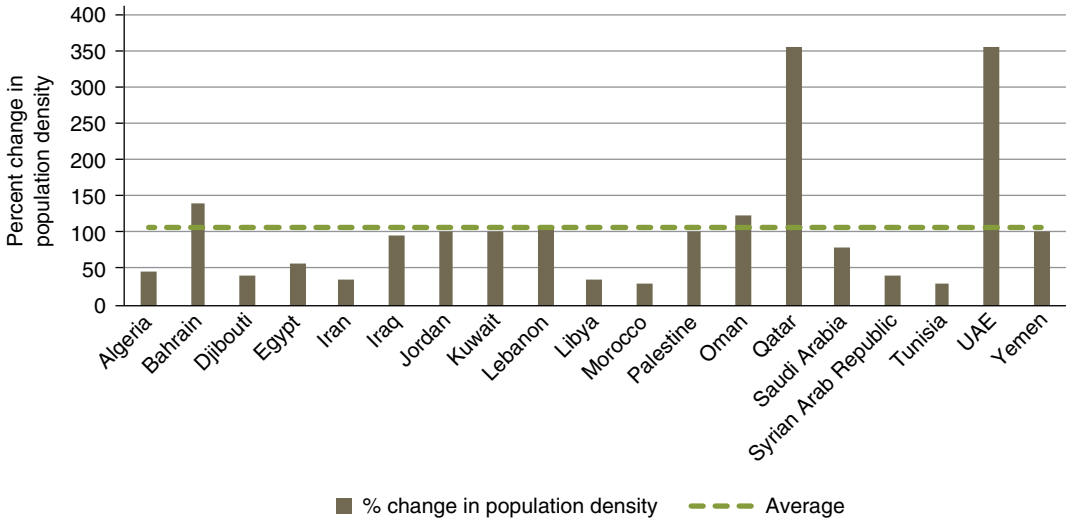
population growth. To meet demands of an increasing population, water is also being withdrawn at an unsustainable pace, as most countries are withdrawing more water than their renewable freshwater resources (Figure 8). Egypt, Saudi Arabia, and Syria are withdrawing at least twice the amount of their renewable supplies. Most countries in MENA are using up almost all renewable water resources and have resorted to depleting their nonrenewable resources to meet agricultural, industrial, and domestic demands.

[18]FAO, "Aquastat Main Database."
[19]World Bank, "Beyond Scarcity: Water Security in the Middle East and North Africa, MENA Development Report."

ANTHROPOGENIC DRIVERS

Population density in MENA has doubled in the past 20 years. The MENA region comprises of 21 countries with a total area of 9.5 million km^2, which represents about 7 percent of the world's total land area. The region's population totaled about 450 million in 2017.[20] MENA experienced the highest rate of population growth of any region in the world over the past century. Urban population has doubled in recent years to 54 percent of total population. The population density has increased twofold since 1994, with countries like Bahrain, Qatar, and UAE experiencing a sharper increase (Figure 9). Higher population densities on lands vulnerable to degradation are likely to exacerbate the problem.

FIGURE 9: CHANGE IN POPULATION DENSITY FROM 1994 TO 2014



Source: FAO AQUASTAT, 2014.

A rising population in MENA translates to rising food demand. Population growth in the MENA region, alongside increased urbanization and industrialization, has resulted in greater demand for water, land, and food. The population is expected to increase by 40–50 percent over the next two decades.[21] Given an annual growth rate of around 3 percent the population is expected to reach 205 million by 2030. MENA's urban population will make up about 80 percent of its total population in 2020.[22] The high population and urban growth rates, together with current consumption patterns, compound pressure on the region's limited land and water resources. Land degradation in Arab countries such as Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Saudi Arabia, United Arab Emirates, and Yemen is primarily caused by rapid population growth and the failure of resource management policies.

Food demand is often met by employing unsustainable farming practices and expanding agricultural land. Policies encouraging intensive agriculture have led to the widespread clearance of land for mechanized farming under monocultures, the removal of trees, and abandonment of traditional crop rotations and other sustainable management practices.[23] Drylands cultivated in this way rapidly lose soil biodiversity—fungi, bacteria, and other organisms—which is important for recycling nutrients and maintaining organic carbon

[20]United Nations, "United Nations Population Division. World Population Prospects: 2017 Revision."
[21]Khordagui, H. "Water Scarcity in West Asia, Ecosystem Dimensions, SDPD-UN-ESCWA."
[22]UNEP, "GEO-5: Global Environment Outlook: Environment for the Future We Want. United Nations Environment Programme (UNEP), Nairobi."
[23]UNEP, "Sudan Post-Conflict Environmental Assessment."

in the soil. Declining organic carbon means less nutrients and less water is retained in the soil, negatively impacting food production and leading to land degradation. In addition, natural water resources are being rapidly depleted to meet the food demand. In the Sahara where rainfall is only a few centimeters a year, water available in aquifers is a nonrenewable resource. Despite this fact, many countries such as Tunisia, Morocco, Algeria, Sudan, Libya, Jordan, and Saudi Arabia are among the nations irrigating with groundwater.

Unsustainable farming practices have increased soil salinity, which is one of the main symptoms of land degradation. Increased salinity is caused by land clearing, mainly for agricultural production, and occurs when the water table rises and brings natural salts to the surface. This is largely the outcome of employing farming practices based on shallow rooting crops and pastures.[24] Mismanagement of groundwater resources, coupled with increasing surface temperatures, evaporation rates, and reduced rates of precipitation, has led to salinization of water and soils in several countries of MENA. The phenomena vary in extent and magnitude from one country to another, and sulphates and chlorides are the main salts increasing in the water and soils of the region.

Indirect factors such as governance and conflict also contribute to land degradation in MENA. Lack of multisectoral planning around natural resources has been a huge issue. In cases where sector planning is disjoint (or in isolation of one another), negative externalities can arise with the interaction of one sector policy negatively affecting the outcome in another sector. Another important driver of land degradation is weak land tenure and ineffective governance over natural resources, particularly in communally managed areas like grasslands and dry forests.[25] These lands have historically enjoyed strong governance through customary arrangements and practices, such as the coordination of harvesting forest and rangeland products, and the establishment of rules to prevent malpractice.[26] In many cases, these institutions are weakening as the result of emerging state powers that undermine customary authority and fail to provide a viable alternative. In addition, violent conflicts in the region have caused enormous and massive migration inside these countries as well as across and beyond the region. Millions of refugees and displaced people have been pushed to abandon their lands, which has led to a contraction in supply through a breakdown in production, the destruction of physical capital, and the dislocation of labor, thus deteriorating both the land and economy.

CLIMATE CHANGE

Climate conditions both lead to and exacerbate land degradation in MENA. Changes in temperature, water, CO_2 and nutrient availability, and extreme events can significantly impact the functioning of ecosystems, with direct and indirect effects on both land degradation and restoration processes. Climate change also shapes the extent, severity, and frequency of occurrence of other degradation drivers, with effects that, in turn, feedback to influence potential future climate. The MENA region is extremely vulnerable to climate change. The arid and semiarid climate of the region and climate change constitute major drivers affecting land, resources, and humans alike, working as a determinant of land productivity and economic development. According to the Intergovernmental Panel on Climate Change (IPCC) it is expected that precipitation will decrease, and temperature will increase, as well as the magnitude and frequency of droughts that will consequently increase over the MENA region in the coming decades.[27]

[24]Carter, "Problems of Salinity in Agriculture."
[25]Mortimore et al., "Dryland Opportunies: A New Paradigm for People, Ecosystems and Development."
[26]El Mangouri, "Dryland Management in the Kordofan and Darfur Provinces of Sudan."
[27]Pachauri et al., *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*

MENA can experience temperature increases up to 4°C and a sea level rise of 0.5 meters by 2099, with negative consequences for agriculture and human lives. Between 1880 and 2012, global average temperatures increased by 0.85°C [0.65°C–1.06°C], with the last three decades experiencing record high temperatures.[28] Even under conservative scenarios, temperatures are projected to rise further, with temperatures at the end of the 21st century likely to be at least 1.5°C higher relative to 1850–1900.[29] In MENA, temperatures may be 4°C higher by 2050, with daytime temperatures reaching 50°C, and 200 days of exceptional heat each year.[30] Rising temperatures lead to sea level rise, to which MENA is among the most vulnerable regions. A sea level rise of 0.5 meters by 2099 could put many low-lying coastal countries such as Tunisia, Qatar, Libya, UAE, Kuwait, and Egypt at risk.[31] In addition, warmer temperatures can also drive degradation by affecting physical processes. Warmer temperatures can alter soil drainage, hydrology, and cause mass movements like landslides and floods, affecting agriculture, as well as human and animal lives.[32, 33] Crop yields could decrease by up to 30 percent at 1.5–2°C and by almost 60 percent at 3–4°C in MENA.[34]

Drought conditions in MENA are likely to get worse and will also lead to reduced agriculture productivity. Globally, precipitation patterns have been changing since the early to mid-1900s, with some regions of the globe witnessing increases and flooding, and others decreases and droughts.[35] MENA has been subject to an almost continuous drought since 1998, according to the National Aeronautical Space Agency (NASA), which says the current dry period is the worst for 900 years.[36] Consistent declines in rainfall over time can reduce vegetation productivity and biomass in sites.[37] In agricultural systems, decreases in rainfall over time and droughts can lead to reduced agricultural productivity, potentially rendering some areas unsuitable for crop production in the future.[38]

MENA is also expected to experience more extreme events such as dust storms and severe droughts, which are driven by climate change. Besides changes in temperature and precipitation, there has also been an increase in the frequency and intensity of extreme events, including heavy rainfall events and temperature extremes in many regions over the last several decades, and these are projected to rise in the coming decades.[39] Extreme events that are particularly pertinent in the MENA region are dust storms and severe droughts. Dust storms can erode top soil, damage crops and infrastructure, reduce air quality, and even disrupt transport networks.[40, 41] Similarly, severe droughts can lower crop productivity, reduce water availability for humans, livestock and wildlife, lead to the loss of

[28]Pachauri et al., 20.
[29]Pachauri et al., *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*
[30]MaxPlanck Institute, "Hot Air in the Orient."
[31]Blankespoor, Dasgupta, and Laplante, "Sea-Level Rise and Coastal Wetlands."
[32]Cheng and Wu, "Responses of Permafrost to Climate Change and Their Environmental Significance, Qinghai—Tibet Plateau."
[33]Jorgenson et al., "Resilience and Vulnerability of Permafrost to Climate Change."
[34]Publications, World Bank, *Turn down the Heat: Confronting the New Climate Normal.*
[35]Pachauri et al., *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 20.*
[36]NASA, "NASA Finds Drought in Eastern Mediterranean Worst of Past 900 Years."
[37]Barbosa, Kumar, and Silva, "Recent Trends in Vegetation Dynamics in the South America and Their Relationship to Rainfall."
[38]Change, IPCC Climate, "Mitigation of Climate Change."
[39]Pachauri et al., *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 20.*
[40]Luino, "Sequence of Instability Processes Triggered by Heavy Rainfall in the Northern Italy."
[41]Clarke and Rendell, "Climate, Extreme Events and Land Degradation."

biodiversity, depress plant performance and survival even in arid and semiarid systems, and make forests more susceptible to die-offs.[42, 43, 44]

Climate change is also a threat multiplier for other degradation drivers. The greatest threat of future climate change arises, perhaps not from its role as a direct driver of degradation, but rather from its ability to act as a threat multiplier for other degradation drivers, both by exacerbating the effects of other land degradation drivers, as well as, by altering the frequency, intensity, extent, and timing of events, such as fires, pest and pathogen outbreaks, and species invasion.[45, 46, 47, 48] For instance, degradation of rangelands as a result of shrub encroachment, wind erosion, invasions by exotic species, and the loss of perennial forage species can increase the risk of negative impacts and the vulnerability of local communities to future climate changes, while also limiting the effectiveness of adaptation strategies—for example, adjusting stocking rates to suit forage availability and reducing the options available to land managers to adapt to future climates.[49, 50]

LAND-USE SPECIFIC DRIVERS

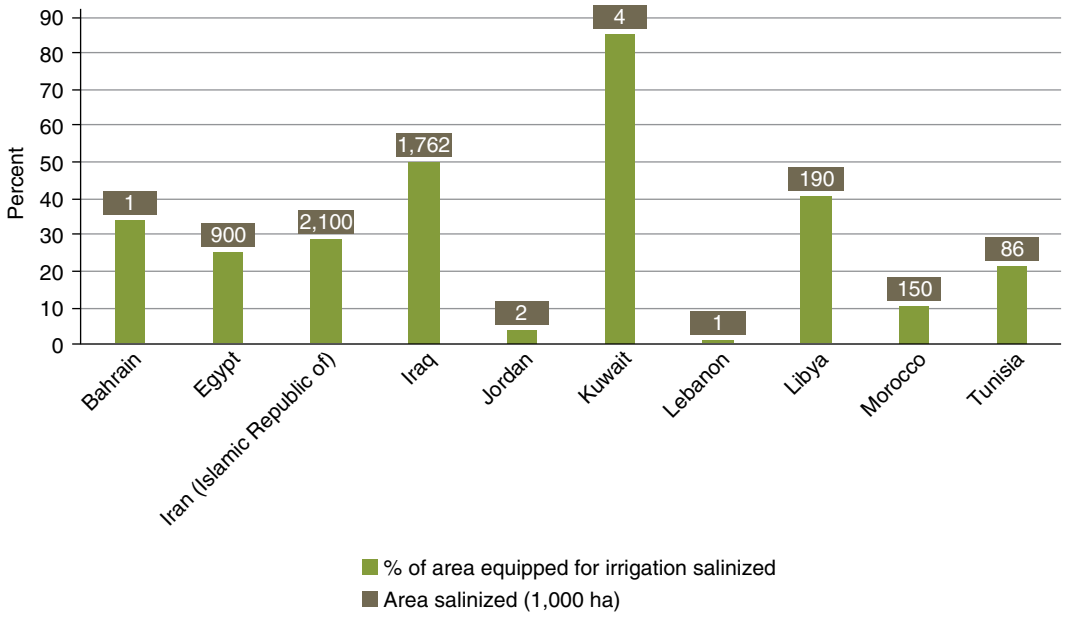
Salinization in irrigated lands, erosion on rainfed croplands, and overgrazing on rangelands are the primary drivers of degradation for these land uses. Salinity combined with waterlogging is the biggest problem for degraded irrigated lands. Sodic soils alone are of minor extent, but saline-sodic soils are widespread, especially in Iraq. Three countries that have about more than a million hectares of irrigated areas that are salinized are Iraq (50 percent); Iran (30 percent); and Egypt (25 percent) (Figure 10). Degradation of rainfed cropland is even greater than that of irrigated cropland. Algeria, Kenya, and Lesotho have more than 80 percent of their rainfed cropland desertified by water erosion. Most of the erosion occurred in the past 50 years due to high population growths and land-use policies. Rangeland is the most extensive among the three major land uses. Few countries have less than 50 percent of their pastoral lands degraded. Overgrazing by livestock is the biggest land problem, coupled with cutting of woody species for fuelwood. The drivers for rangeland degradation are low intensity characters of pastoral land use, the slow response to land management changes, and social and economic pressures associated with reducing livestock numbers on heavily used rangelands.

REGIONAL CHARACTERISTICS

Within the MENA region, there are important sub-regional distinctions that influence the course of desertification. The MENA region is vast so countries have unique climatic conditions. The flat plains and undulating hills of the countries surrounding the Mediterranean Sea are dependent on scant winter rainfall (200–350 mm per year) and short rainy seasons to cultivate low yielding cereal, legume and tree crops, together with sheep and goat herding on fragile, low productivity rangelands. Nile River Valley agriculture,

[42]Clarke and Rendell.
[43]Hoover, Duniway, and Belnap, "Testing the Apparent Resistance of Three Dominant Plants to Chronic Drought on the Colorado Plateau."
[44]Lewis et al., "The 2010 Amazon Drought. Science."
[45]Allen et al., 2010. A Global Overview of Drought and Heat-Induced Tree Mortality Reveals Emerging Climate Change Risks for Forests. Forest Ecology and Management. 259, 660–684. Doi: 10.1016/j.foreco. 2009.09. 001."
[46]Mainka and Howard, "Climate Change and Invasive Species: Double Jeopardy."
[47]Webb et al., "Land Degradation and Climate Change: Building Climate Resilience in Agriculture."
[48]Montanarella, L., Scholes, R., and Brainich, A., "The IPBES Assessment Report on Land Degradation and Restoration."
[49]Webb et al., "Land Degradation and Climate Change: Building Climate Resilience in Agriculture."
[50]Briske et al., "Climate-change Adaptation on Rangelands: Linking Regional Exposure with Diverse Adaptive Capacity."

FIGURE 10: PERCENTAGE AND AREA OF IRRIGATED LAND SALINIZED



Source: FAO Aquastat, 2000.

in contrast is based on intensively-managed irrigated systems. The enormous population pressure and lack of rainfall in this zone makes it heavily dependent on maximizing food production per unit of land, which increases risks of salinity build-up, water pollution, water shortages, and ecological damage. The Arabian Peninsula depends on groundwater raised through wells, but groundwater is being depleted faster than the scant rainfall can replenish it. Looking eastward toward Iran and Pakistan, aridity is complicated by rugged mountainous terrain and more extreme temperature variability, especially colder winters. Irrigation in intermountain basins often raises soil salinity because the salt-laden water does not easily drain out of these low lying areas. Irrigation on steep land often scars the land with erosion gullies.

Besides climatic factors, many MENA countries have unique socioeconomic factors that drive land degradation. The causes and effects of land degradation differ among countries in MENA. While geography and climate play a big part in land management practices, in most cases countries are undergoing urbanization, economic development, or conflict which lead to further unsustainable practices. Some of these drivers and their consequent effects are highlighted in Box 2, Box 3, and Box 4.

BOX 2: URBANIZATION AND ECONOMIC DEVELOPMENT IN NORTHWEST AFRICA AND ISRAEL

The northwestern Maghreb covers northwest Africa between the Mediterranean Sea and the Sahara Desert (Morocco, Algeria, and Tunisia). The region has experienced major land-use changes since gaining political independence around 1960 and is now undergoing dynamic economic changes. Traditional knowledge, combined with new land-use opportunities, underlies current, specific drivers of land degradation: the movement of population to urban areas of emerging economic activity comes at the expense of the abandonment of rural areas, the extension of arable land into forested areas, soil salinization, and overgrazing. Climate conditions are often harsh, including extreme droughts and rainfall events, and associated floods. New agricultural developments include drilling boreholes, ploughing hillslopes, and building roads for moving livestock, all of which aim to increase local production in the short term at the expense of long-term land sustainability.

In Israel, dryland degradation and soil salinization are mostly caused by agricultural expansion and urban development. The Israeli government considers its semiarid areas, which are most prone to degradation, as a security risk, so the government has encouraged settlement in those areas along with agricultural development, afforestation projects, or ecosystem rehabilitation. As a result of this, exploitation and grazing pressure throughout the degraded dryland areas have been reduced. The government's effort in reducing degradation worked until recent decades, when dryland degradation has reemerged as an issue. For example, large scale salinization has occurred from expansion of irrigated agriculture through the use of nondesalinated treated wastewater. Intensification of development has thus led to further degradation.

Source: WAD3—JRC; Safriel, 2006.

BOX 3: RANGELANDS IN JORDAN, SAUDI ARABIA, AND SYRIA

Rangeland in Jordan covers more than 80 percent of the country's total area and is mainly used for pastoralism and agriculture. It is mostly under tribal rights, which have created land-use conflict and mismanagement leading to overgrazing, land degradation, and ultimately desertification. Human impacts through livestock overgrazing are, possibly, the main cause of the land's deterioration, to such a degree that it is no longer able to support the livestock that used to graze there. Additionally, rainfed agricultural practices in semiarid rangelands causes soil erosion and dust storms during drought seasons.

Saudi Arabian rangelands have deteriorated too, where rangelands are estimated at 146 million hectares, most of which receives rainfall of less than 100 millimeters per year. About 33 percent of rangelands are in average condition with dry matter productivity of 88 kilograms per hectare per year, whereas 28 percent are in poor condition with dry matter productivity of 35 kilograms per hectare per year. Overgrazing and woodcutting continue to be major pressures on these resources despite regulations. It is perceived that better transport, increased access to water points, and subsidies given to shepherds and herd owners in Saudi Arabia were the main reasons for rising pressure on rangelands, which in turn led to their degradation by heavy grazing.

In Syria, 10 million hectares of rangelands, officially known as the Badia, represent 55 percent of the country's land area. Within this area, 8–12 million animals are freely grazed by Bedouin communities. The area's contribution to sheep feeding requirements in the year 2000 had fallen by more than 50 percent compared to 1993. The situation is unlikely to have improved since the onset of conflict in the country.

Source: Jordan Ministry of Agriculture 2014; AOAD 2015; IFAD 2012.

BOX 4: SALINITY IN IRAQ

In Iraq 97 percent of its total area is arid, about 50 percent of which is desert. Desertification affects 39 percent of the country's surface area with an additional 54 percent under threat. Arable land degradation is ongoing, caused by various factors including mismanagement, climate change, and water scarcity, and has accelerated the rise of soil salinity, increased the rate of soil erosion and converted wetland to dryland.

It is estimated that Iraq loses around 250 square kilometers of arable land annually. Although Iraq has the largest area of available farmland in the region, it suffers the most from soil salinity and wind erosion. In Mesopotamia, where most of the fertile land exists, the near-surface water table associated with a very high evaporation rate has created ideal conditions for soil salinization.

Source: FAO 2011.

COSTS AND IMPACTS OF LAND DEGRADATION

GLOBAL LAND DEGRADATION COSTS

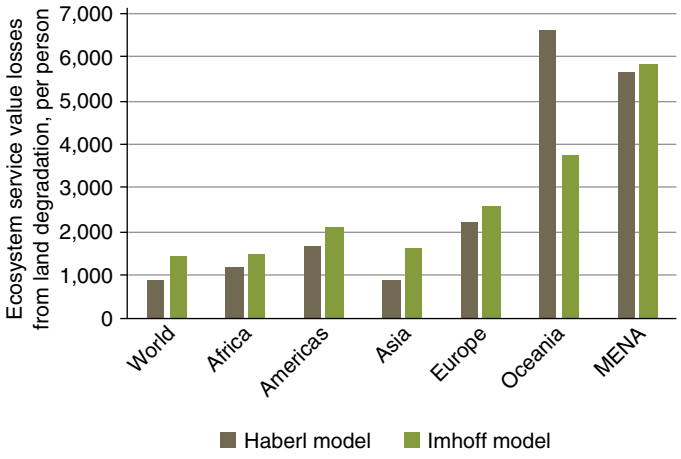
Land degradation currently costs the world 10.6 trillion USD, which can more than double in the next 30 years if unaddressed. Agriculture production losses, livelihood reductions, and ecosystem service losses cost the world as much as 10.6 trillion USD, equaling to about 17 percent of global GDP.[51] About 75 billion tons of soil have been lost globally, costing the world around 400 billion USD per year. Additionally, Asia and Africa bear the highest costs of land degradation, estimated at 84 billion USD and 65 billion USD per year, respectively. If unchecked, the global economy can lose up to 23 trillion USD by 2050, where the cost of immediate action is about 4.6 trillion USD, only 20 percent of predicted losses.[52]

Ecosystem service losses from land degradation in MENA are about four times as much as the global average. Land provides many different ecosystem services, each of which has a socioeconomic benefit that in some cases are not reflected by market values. They provide food and fuel, as well as regulating services such as soil, water, and air. Land degradation from an economic perspective is therefore a loss in services provided to societies as a whole. Using the ecosystem service approach, the MENA region fairs relatively poorly when accounting for both population and land area. In particular, ecosystem service losses are about 5,600 USD per person or about 300,000 USD per km^2 in MENA, compared to the world average of 1,000 USD per person and 50,000 USD per sq km (Figure 11 and Figure 12).[53]

In addition, MENA ranks lowest in terms of land productivity and value globally. Land degradation negatively affects land value and its productivity and signals how costly it is. The value of agricultural land, measured by net primary productivity, has most significantly declined for the MENA region in the past 20 years, with about a 50 percent decrease in value (Figure 13).[54] Additionally, Figure 14 shows a comparison of the growth in land productivity in the MENA region versus other developing regions. Since the 1980s, agricultural growth in MENA is ranked the lowest relative to other developing regions.[55]

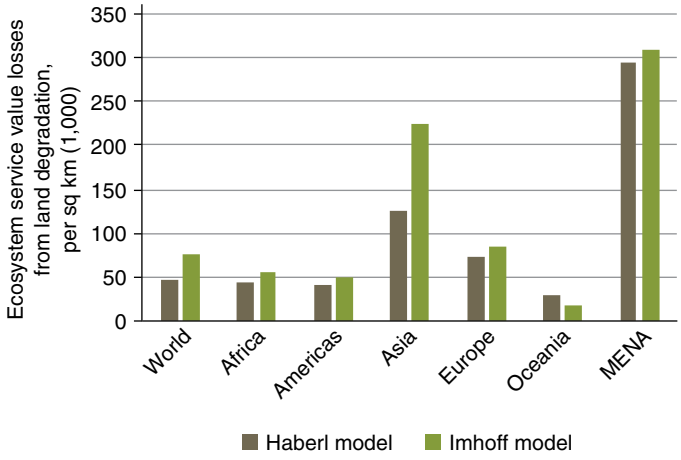
[51]Initiative, "The Value of Land: Prosperous Lands and Positive Rewards through Sustainable Land Management."
[52]UNCCD, "LDN Country Profiles."
[53]Haberl et al., "Quantifying and Mapping the Human Appropriation of Net Primary Production in Earth's Terrestrial Ecosystems."
[54]Ibid.
[55]FAO, "Aquastat Main Database."

FIGURE 11: ECOSYSTEM SERVICES LOSSES PER PERSON



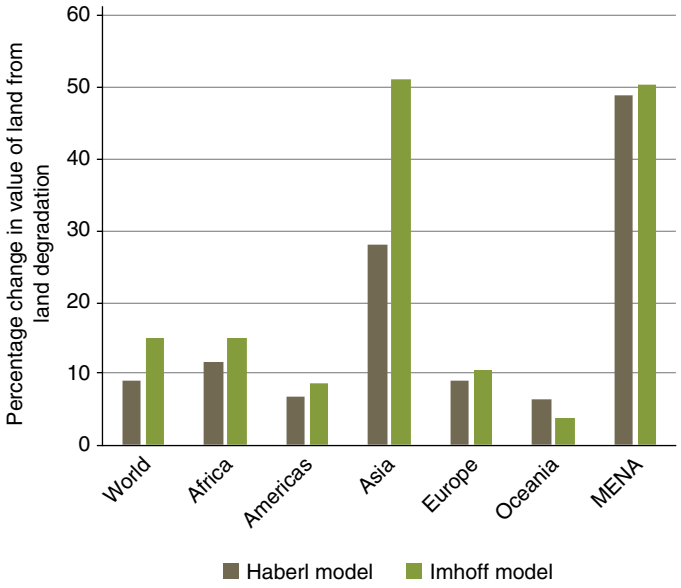
Source: Haberl et al., 2007.

FIGURE 12: ECOSYSTEM SERVICE LOSSES PER KM^2



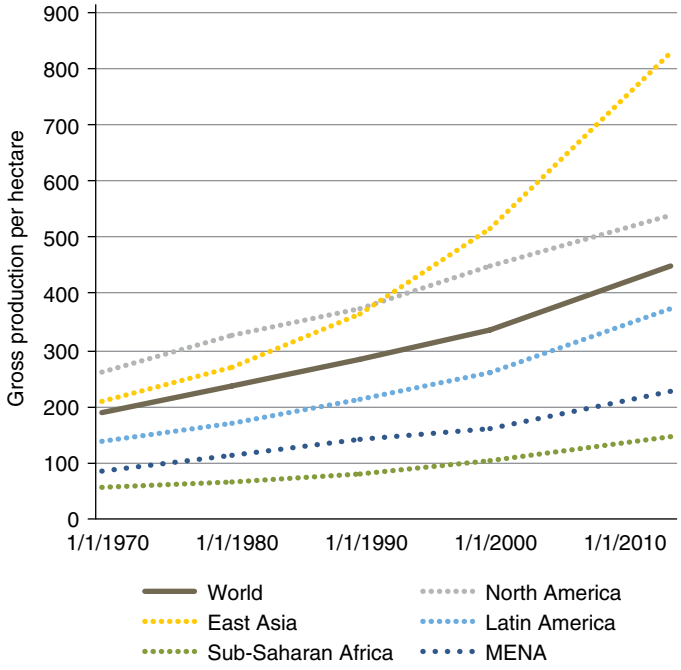
Source: Haberl et al., 2007.

FIGURE 13: CHANGE IN VALUE OF LAND BY REGION



Source: Haberl et al., 2007.

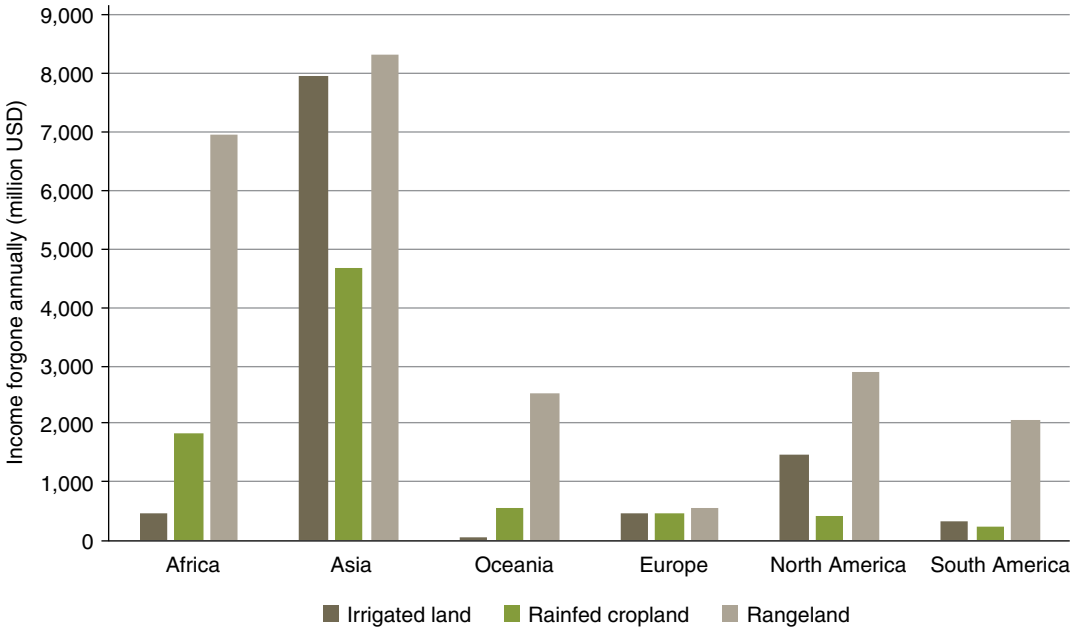
FIGURE 14: TREND OF PRODUCTION PER HECTARE BY REGION



Source: FAO, 2018.

Africa and Asia (comprising of MENA), experienced the highest relative reduction in income from rangelands, while irrigated lands cost Asia the most. Productivity losses due to land degradation exact a price that appears as the annual value of agricultural production foregone because of degradation. A 40 percent loss in productivity was assumed for at least moderately degraded land. While these calculations only aggregate by continent, it is still noteworthy that Africa and Asia experience the highest income losses across the three land types (Figure 15). Degraded rangelands affect both Africa and Asia severely, costing them over 7,000 million USD each year each. Degraded irrigated lands

FIGURE 15: INCOME FORGONE DUE TO DESERTIFICATION ANNUALLY BY CONTINENT



Source: Dregne and Chou, 1992.

affects Asia the most, with about 8,000 million USD loss in income annually, over five times that of other continents.[56] While these estimates are from over two decades ago, they prove that desertification has been a costly issue and has likely worsened.

ECONOMIC COSTS OF LAND DEGRADATION IN MENA

Land degradation costs MENA countries an average of 1 percent of their GDP just from agriculture productivity losses, which is relatively costlier than other environmental degradation problems in the region. A study in 2007 found that costs of environmental degradation reached about 17.4 billion USD in seven MENA countries, and varied from about 2 percent to 7.5 percent of national GDP among countries (Table 6).[57] On average, land degradation costs MENA countries about 1 percent of their national GDPs, ranging from 0.4 to 2.5 percent among the seven countries in the study.[58] This estimate is significantly understated as it only considers yield declines. Land degradation costs are relatively higher than other environmental degradation indicators for Algeria, Syria, and Iran. For most countries, air pollution impacts, which are also partly driven by land degradation, are as costly or costlier than land degradation.

Countries in MENA have unique symptoms and costs of land degradation. The costs usually comprise of three broad categories: (1) health costs of the population (morbidity, mortality, pain, illnesses, discomfort, etc.); (2) economic losses (such as reduced yield and

[56]Dregne and Chou, "Global Desertification Dimensions and Costs."
[57]Ahmed Hussein, "Costs of Environmental Degradation: An Analysis in the Middle East and North Africa Region."
[58]Precise data are not available for each source of land degradation, so orders of magnitude have been estimated to give some perspective on the economic impact.

TABLE 6: ENVIRONMENTAL DEGRADATION COSTS AS A PERCENTAGE OF GDP, 2000

	Algeria	Egypt	Lebanon	Morocco	Syria	Tunisia	Iran
Air pollution	1	2.1	1	1	1.3	0.6	1.6
Lack of access to WASH	0.8	1	1.1	1.2	0.9	0.6	2.82
Land degradation	**1.2**	**1.2**	**0.6**	**0.4**	**1**	**0.5**	**2.5**
Coastal degradation	0.6	0.3	0.7	0.5	0.1	0.3	0.15
Waste management	0.1	0.2	0.1	0.5	0.1	0.1	0.36
Subtotal	**3.6**	**4.8**	**3.4**	**3.7**	**3.3**	**2.1**	**7.43**
Global environment (CO_2 emissions)	1.2	0.6	0.5	0.9	1.3	0.6	1.36
Total	**4.8**	**5.4**	**3.9**	**4.6**	**4.6**	**2.7**	**8.8**

Source: Ahmed Hussein, 2008.

reduced quality); and (3) environmental costs (such as loss of biodiversity, reduced recreation, etc.). Reduced yield is usually the largest economic cost of land degradation. For instance, over 40 percent of Syria's irrigated land is affected by soil salinity to varying degrees. About 125,000 hectares suffer from high soil salinity, resulting in a 37 percent decline in yields for main irrigated crops. This translates to a total annual loss of 80 million USD or 0.45 percent of GDP.[59] However, many countries have varying and disproportionate types of land degradation costs. For instance, soil erosion in cereal agricultural systems in Africa costs as much as 127 billion USD a year or 12 percent of the average GDP of African countries (Box 5). In addition, agricultural land degradation costs in Morocco are substantial, whereas rangeland and forest degradation costs in Jordan are problematic (Box 6 and Box 7). For Lebanon, uncontrolled quarrying in the past has caused major destruction of natural vegetation and habitat. A revealed preference study showed that the price of property overlooking three abandoned quarries were lower than prices for comparable properties farther away from quarries by 90 million USD.[60]

BOX 5: SOIL EROSION COSTS IN AFRICA

Soil nutrient loss on arable land in Africa has been considered highly detrimental to agricultural ecosystems and cereal production. Given that cereals provide for about 50 percent of daily calories supply per capita (FAOSTAT), soil nutrient loss on African croplands provides a serious impediment for rural livelihoods and food security.

A study undertaken for the Economics of Land Degradation (ELD) Initiative provides a cost-benefit analysis on erosion-induced soil nutrient depletion on croplands across 42 African countries. Crop yield loss is estimated econometrically by relating soil nutrient balance and crop production. The annual value of crop losses is then derived by multiplying marginal physical product of soil nutrients by market price of a set of 12 crop types.

The depletion of soil nutrients as supporting ecosystem service will cost the 42 analyzed countries about 280 million tons of cereals per year. In present value terms, this cost of inaction is about USD 4.6 trillion (in Purchasing Power Parity terms, PPP) over the next 15 years, which is USD 286 billion PPP per year (or USD 127 billion/year at 2011 constant dollar) or 12.3 percent of the average GDP of all the countries in the study.

Source: Tilahun et al., 2015.[61]

[59]Ahmed Hussein, "Costs of Environmental Degradation: An Analysis in the Middle East and North Africa Region."
[60]Ibid.
[61]Tilahun et al., The Economics of Land Degradation.

BOX 6: LAND DEGRADATION COSTS IN MOROCCO

An estimated 8.7 million hectares of 19 percent of Morocco's land is subjected to severe degradation, with agriculture activities being the only driver for the degradation.

The cost of cropland degradation is estimated in three steps:

1. Estimating the share of degraded land in total cropping area

2. Estimating the impact of land degradation on crop productivity

3. Assessing the cost of degraded cropland

Because most of the land is cultivated with cereals, the loss of agricultural yield is estimated in terms of lost cereal productivity due to land degradation. Estimated yield decreases corresponding to light and moderate degradation would be 0.5 quintals per hectare and 2 quintals per hectare respectively. Using this range and selling price of the cereals, cost of degradation ranges from 78 million USD to 157 million USD.

Source: Croitoru and Sarraf, 2010.[62]

BOX 7: COSTS OF RANGELAND AND FOREST DEGRADATION IN JORDAN

Rangelands in Jordan are deteriorating due to rising demand and unsustainable management practices. The growing demand for animal products has led to overgrazing, resulting in lower fodder productivity. About 17,705 tons of forage (barley equivalent) is annually lost to overgrazing. Valued at a price of JOD 200/t of barley, the annual cost of forage loss is about Jordanian Dinars (JOD) 3.5 million.

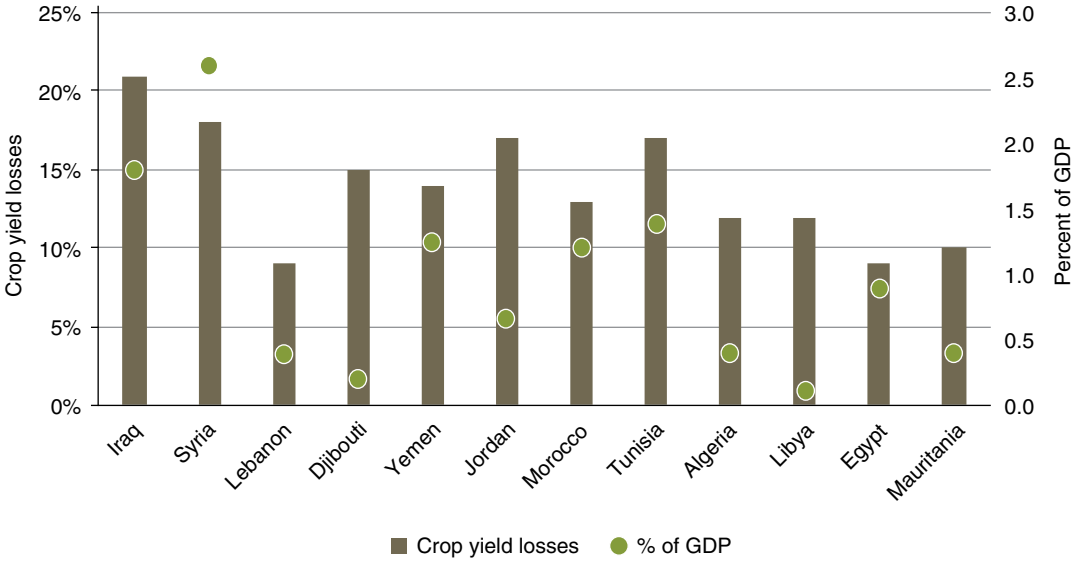
Large forested areas in Jordan are threatened by pests, misuse, and pressures resulting from energy shortages in rural areas. A study found that tourists are willing to pay a premium of around 70 USD per day for unspoiled destinations. Adjusting for GDP per capita and total tourist populations visiting the region, the cost of forest degradation is estimated at JOD 7.2 million.[63]

Source: World Bank, 2009.[64]

Yield losses account for 0.95 percent of GDP in MENA, according to another study. A more updated study, looking at 12 MENA countries, estimated land degradation costs by considering crop cultivation. Estimates are based on assumptions about crop yield reductions and crop distributions among levels of degraded lands. National average yield losses in lands that are mildly degraded are estimated to be about 10 percent in six counties, 14 percent in four countries, and 19 percent in the other four countries.[65] Applying these yield losses to the value of annual crop production provides estimates of annual cost of land degradation. Annual cost is estimated at 6.4 billion USD in 12 countries in 2007. On average, land degradation costs about 0.95 percent of GDP and ranges from 0.2 percent of GDP in Libya and Djibouti to 2.6 percent of GDP in Syria (Figure 16). The large variation in cost

[62]Croitoru and Sarraf, The Cost of Environmental Degradation: Case Studies from the Middle East and North Africa.
[63]Huybers and Bennett, "Impact of the Environment on Holiday Destination Choices of Prospective UK Tourists: Implications for Tropical North Queensland."
[64]The World Bank, "Hashemite Kingdom of Jordan Country Environmental Analysis."
[65]Larsen, "Cost Assessment of Environmental Degradation in the Middle East and North Africa Region: Selected Issues."

FIGURE 16: CROP YIELD LOSSES AND LOSSES AS A PERCENTAGE OF GDP BY COUNTRY



Source: Larsen, 2011.

across countries is only to some extent explained by variation in the magnitude of yield losses from land degradation. More important is the size of the agriculture sector. For instance, the low cost in Libya and Djibouti reflects these countries' low share of agriculture in GDP.

The economic costs of land degradation in MENA are hard to estimate due to outdated data and the challenges of valuing impacts. Comprehensive and updated economic valuations of land degradation in MENA are lacking. In addition, monetizing costs of land degradation is very challenging given the lack of reliable data and the challenges associated with valuing indirect impacts, such as sand storms and biodiversity. The previous two studies provide estimates from 2000 and 2007 respectively, with some varying results. Another study on land degradation from 2007 in the Mediterranean region estimates that land degradation costs make up about 3.2–6.4 percent of Egypt's GDP and 3.6 percent of Algeria's GDP, which are double the estimates from the other studies.[66] Such inconsistencies are expected given the difference in methodologies and challenges with valuing costs. However, these studies still provide a range of costs that is alarming.

IMPACTS AND RISKS OF LAND DEGRADATION

Land degradation has various damaging impacts, which are usually not captured by economic costs. Economic costs are imperative in demonstrating the magnitude of a problem but are often very challenging to estimate. An issue like land degradation, which is hard to even define and measure, has complex and wide-ranging impacts. While an impact such as decreased agricultural yield is a substantial and noticeable one and easier to value, monetized costs that only consider lower yields are underestimated. Land degradation has

[66]Montanarella, L. 2007. The EU thematic strategy for soil protection and its implications in the Mediterranean. In Zdruli, P., Trisorio, P. and Liuzzi, G. (Eds.). Status of Mediterranean soil resources: actions needed to support their sustainable use, Mediterranean Conference, Tunis, Tunisia, 26–31 May 2007.

TABLE 7: DIRECT AND INDIRECT IMPACTS OF LAND DEGRADATION

Direct	Indirect
Decreased agricultural productivity	Reduced stream flow and irrigation water flow
Salinity, alkalization, waterlogging, soil erosion, and compaction	Worsened drinking water quality
	Siltation of water systems
Reduced soil fertility	More dust storms
Nutrient depletion	Poverty
Decreased resilience to climate change	Food insecurity and malnutrition
Reduced carbon sequestration capacity	Negative health impacts from dust storms, water quality, etc.
Lower animal fodder	
Lower wood production	Increased conflict and forced displacement
Slower groundwater recharge	Negative impacts on cultural values
Decreased grazing and hunting	
Reduced tourism	

Source: UNCCD, 2012;[67] Low, 2013.[68]

other immediate consequences, such as reduced biodiversity, and many indirect impacts such as increased dust storms, poverty, and displacement (Table 7). Discussions on land degradation must therefore be supplemented by listing and explaining a range of pertinent impacts.

AGRICULTURAL PRODUCTIVITY

Even though there are many factors that affect agriculture productivity, land degradation significantly and negatively impacts agricultural productivity. As land degradation is synonymous with soil degradation and long-term loss of vegetation, the impact on crop yields is the most noticeable one. Soil and land degradation are interrelated issues and often come up in the same context. Yields of grains and other crops could decrease substantially across MENA as soil further degrades. In the MENA region, a doubling of carbon dioxide would lead to a 20 percent reduction in wheat, corn, and other coarse grains.[69] However, the relationship between agricultural productivity and land degradation is not straightforward because soil degradation is both a driver and result of land degradation. In addition, productivity is affected by many different factors, such as weather, disease, pests, farming practices, and external market forces.

Soil erosion

Soil erosion is one of the most damaging components of land degradation. Just as soil degradation is a component of land degradation, soil erosion is a component of soil degradation. Soil erosion is defined as the wearing away of topsoil due to wind, water, or farming practices, and topsoil is the most fertile layer as it contains organic nutrient rich materials. Erosion is a natural process but is strongly accelerated by agriculture and mismanagement.[70] Soil erosion could account up to 10 percent of yield reduction losses globally, equivalent to an area of 4.5 million ha per year.[71, 72] On a global scale the annual loss of 75 billion tons of soil costs (at 3 USD per ton of soil for nutrients and 2 USD per ton of soil,

[67]UNCCD, United Nations Convention to Combat Desertification, 2012.
[68]Low, "Economic and Social Impacts of Desertification, Land Degradation and Drought."
[69]European Committee of the Regions, "The Relationship between Desertification and Climate Change in the Mediterranean."
[70]Montgomery, "Soil Erosion and Agricultural Sustainability."
[71]FAO, "Status of the World's Soil Resources (SWSR)–Main Report," 2015.
[72]Foley et al., "Solutions for a Cultivated Planet."

for water) the world about 400 USD billion per year, or approximately 70 USD per person per year.[73] The productivity of some lands in Africa has declined by 50 percent because of soil erosion and desertification.[74] There are also serious (20 percent) productivity losses caused by erosion in Asia, especially in India, China, Iran, Israel, Jordan, Lebanon, Nepal, and Pakistan.[75]

Soil compaction

Unsustainable agricultural practices have led to soil compaction, which also negatively impacts agricultural yield. Compaction of soil is the compression of soil particles into a smaller volume, which reduces the size of pore space available for air and water. Soil compaction is a worldwide problem, especially with the adoption of mechanized agriculture. It has caused yield reductions of 25 to 50 percent in some regions of Europe and North America, and between 40 and 90 percent in West African countries.[76, 77, 78] On-farm losses through land compaction in the USA have been estimated at 1.2 billion USD per year.[79]

Soil nutrient deficiency

Land degradation also results in a decline in soil fertility, which has had huge economic costs. Soil nutrient balance is the net gain or loss of nutrients from the soil. A negative balance indicates declining soil fertility, whereas a positive balance indicates a net gain and that one or more plant nutrients are entering soil systems faster than being removed. Nutrient depletion as a form of land degradation has a severe economic impact at the global scale. Annual depletion rates of soil fertility were estimated at 22 kg Nitrogen (N) and 3 kg Phosphorus (P) in Sub-Saharan Africa.[80] In Zimbabwe, soil erosion results in an annual loss of N and P alone totaling 1.5 billion USD. In South Asia, the annual economic loss is estimated at 600 million USD for nutrient loss by erosion, and 1,200 million USD due to soil fertility depletion.[81, 82]

Salinization

Another form of soil degradation is salinization, affecting many arid and semiarid regions in the world. Salinization is when soils degrade due to an excess amount of neutral salts. Excess salts can damage plants by altering their ability to absorb water. Salts can build up from salty groundwater, precipitation, or irrigation. Productivity of irrigated lands is severely threatened by a build-up of salt in the root zone. An estimated 950 million ha of salt-affected lands occur in arid and semiarid regions, nearly 33 percent of the potentially arable land area of the world. About 20 percent of irrigated cropland has salt-induced yield declines causing an estimated economic loss of 27.3 billion USD.[83]

[73]Lal, "Soil Erosion Impact on Agronomic Productivity and Environment Quality."
[74]Dregne, "Erosion and Soil Productivity in Africa."
[75]Dregne and Chou, "Global Desertification Dimensions and Costs."
[76]Eriksson, Haekanson, and Danfors, The Effect of Soil Compaction on Soil Structure and Crop Yields.
[77]Charreau, "Problèmes Posés Par l'utilisation Agricole Des Sols Tropicaux Par Des Cultures Annuelles."
[78]Kayombo and Lal, "Responses of Tropical Crops to Soil Compaction."
[79]Gill, "Economic Assessment of Soil Compaction."
[80]Stoorvogel, Smaling, and Janssen, "Calculating Soil Nutrient Balances in Africa at Different Scales."
[81]Stocking, "The Cost of Soil Erosion in Zimbabwe in Terms of the Loss of Three Major Nutrients."
[82]Young, Land Degradation in South Asia: Its Severity, Causes and Effects upon the People.
[83]Qadir et al., "Economics of Salt-induced Land Degradation and Restoration," 2014.

FOOD SECURITY

Land degradation generally means that less food is produced on the land, which has a direct impact on the health and well-being of inhabitants. Soil degradation contributes to lower crop yields and rangeland degradation impacts livestock production. Given the high rate of population growth in MENA, adequate levels of food production are essential to ensure that there is sufficient production to maintain export levels and feed people. However, the number of food-insecure people increased between 1990 and 2005, according to the Global Hunger Index (GHI).[84] Food insecurity can lead to malnutrition, starvation, and ultimately famine. Among all world regions, MENA is the only region that experienced an increase in the proportion of undernourished people over the past decade.

POVERTY

Desertification impacts poverty through various channels, such as increased prices, lower output for farmers, and increase in disaster risks. Food insecurity is synonymous with poverty, which hits lower income groups first. Food scarcity translates to increased food prices, leading to increased poverty. This can create a vicious cycle since the poorest also face the greatest challenge in addressing land degradation. People living in more marginal environments are usually poorer than the average.[85] They are dependent on ecosystem services derived from land that becomes degraded. Lower income groups also depend on the agriculture sector the most and tend to have access to less productive land, making them very vulnerable to the effects of land degradation. Poorer people also have fewer financial resources to invest in technologies or remedies for land degradation. The poor also rely on fuelwood to meet their energy needs. Land degradation creates higher labor demands on fuelwood-dependent households, burdening labor from these households.

SAND AND DUST STORMS

Land degradation can drive sand and dust storms, which have huge economic and health costs. Sand and dust storms occur when high winds impact dry and degraded soils. The largest areas of high dust are in the "dust belt," concentrated in the MENA and Central/South Asia region. Dust can rise in the atmosphere and be transported long distances, making it a significant transboundary issue. Dust in turn impacts health, agriculture, and infrastructure, where a single storm can cost hundreds of millions of USD. The removal of vegetation, loss of biodiversity, and disturbance of soil sediment contribute substantially to dust generation. Dust and sand storms events have increased by 25–50 percent in the last century due to land degradation and climate change.[86] The health effects of dust pollution are immense (Box 8). Dust particles can cause asthma, bronchitis, and silicosis, while fine dust increases the risk of cardiovascular and respiratory diseases. The processes and impacts of sand and dust storms are discussed further in the complementary report titled, *'Sand and Dust Storms in the Middle East and North Africa (MENA) Region—Sources, Costs, and Solutions.'*

HEALTH

Besides malnutrition, land degradation can negatively impact human health through many ways. Land degradation contributes to sand and dust storms which

[84]Breisinger et al., "Food Security and Economic Development in the Middle East and North Africa."
[85]Altieri, "Agroecology: The Science of Natural Resource Management for Poor Farmers in Marginal Environments."
[86]UNEP, "UNCCD Global Assessment of Sand and Dust Storms."

BOX 8: IMPACTS OF SAND AND DUST STORMS

Globally, welfare losses from dust are approximately 3.6 trillion USD, where costs are about 150 billion USD and over 2.5 percent of Gross Domestic Product (GDP) on average in MENA. Dust storm costs range from negative health impacts, to reducing crop yields, to lowering property values, to steering talented workers away from polluted places. The World Health Organization estimates that seven million people die from poor air quality every year, which is at least partly attributed to dust. A study prepared by the World Bank and the Institute of Health Metrics and Evaluation (IHME) calculated welfare losses from ambient $PM_{2.5}$ pollution for each country, where welfare losses represent the cost of premature mortality. Global welfare losses from premature mortality are huge and increasing, as they increased from 2.2 trillion in 1990 to 3.6 trillion USD in 2013. For MENA, dust concentration and storms cost MENA over 150 billion USD annually and over 2.5 percent of GDP for most countries in the region. According to the UN, about 13 billion USD are lost every year from dust storms alone in the MENA region. Additionally, welfare losses from $PM_{2.5}$ were about 141 billion USD in 2013 in the MENA region, and an average of 2.5 percent of the GDP in MENA countries. The biggest welfare losses were incurred by Egypt, Iran, and Pakistan.

Source: World Bank and IHME, 2016.

cause many respiratory illnesses. Unsustainable land management can increase the risk of novel diseases such as Ebola, Monkey Pox, and the Marburg virus. Altered hydrological regimes affect the prevalence of pathogens and vectors that spread disease.[87] In addition, land degradation increases the risk of being exposed to hazardous air, water, and land pollution. The mental health and spiritual well-being of indigenous peoples and local communities are also affected.

CLIMATE CHANGE

Factors that lead to land degradation also contribute toward climate change, which has enormous negative impacts on food security and poverty. Climate change as a driver of land degradation often interacts, at local and regional scales, with biophysical processes, exacerbating existing productivity challenges and existing risks to local productive systems and food security. Prolonged droughts in certain types of drier ecosystems and forests may turn them more susceptible to wildfires, which may cause further land degradation and vulnerability to subsequent droughts and fires in a vicious cycle.[88] For instance, in the Amazon, interactions between deforestation and climate drive the frequency and magnitude of wildfires, with implications for indigenous and local communities' livelihoods, and food security.[89] While climate change can drive land degradation, land use and land degradation can also significantly contribute toward climate change. Cultivation of crops, livestock management, deforestation, and other land-use changes are substantial contributors of human-induced GHG emissions, accounting for 24 percent of 2010 global GHG emissions.[90]

[87]Scholes et al., "Summary for Policymakers of the Thematic Assessment Report on Land Degradation and Restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services."
[88]Soares-Filho et al., "Forest Fragmentation, Climate Change and Understory Fire Regimes on the Amazonian Landscapes of the Xingu Headwaters."
[89]Brando et al., "Abrupt Increases in Amazonian Tree Mortality Due to Drought–Fire Interactions."
[90]Field, Climate Change 2014—Impacts, Adaptation and Vulnerability.

WATER

Land degradation affects water through reduced water infiltration, increased droughts, and decreased water quality. Land degradation can disrupt water cycles through the siltation of rivers and reservoirs. Flooding occurs more frequently on degraded lands as rainwater runs off rather than soaking into the soil, which in turn lowers the top soil and biodiversity, and sometimes may lead to flooding of downstream communities and land.[91] The decline in soil organic matter results in a loss of capacity of soil to hold moisture. Water infiltration can also be reduced by surface compaction, loss of soil invertebrates, and other factors related to desertification, leading to drier soil, lowered aquifers, and soil erosion. Therefore, droughts can occur more frequently independent of changes in rainfall, due to the lowered capacity of the land to capture and hold water. Reductions in water availability will hit southern Mediterranean countries the hardest. In Egypt, Libya, Tunisia, Algeria, Morocco, Syria, and Lebanon, water availability already falls below 1,000 m^3 per person per year—the benchmark for water scarcity.[92] Additionally, as sea level rises, water supplies could become unusable due to saltwater intrusion. Water pollution would also worsen as concentrations of pollutants rise due to reductions in river flow and surface runoff.

ECOSYSTEMS

Land degradation negatively impacts ecosystems leading to wildlife extinction in many parts of the world. Ecosystems affected by land degradation include forests, rangelands, and wetlands. Many valuable ecosystems could be lost as species fail to keep up with the shift in climate boundaries. Wetland sites will face the dual threats of drying out and sea level rise. Wetlands are partially degraded, with 54 percent lost globally since 1990.[93] Land degradation, including urbanization and employing intensive agricultural systems involving high use of chemicals, leads to eutrophication of water bodies by fertilizers and toxic effects of pesticides on nontarget species. Between 1970 and 2012, wild terrestrial vertebrate species declined by about 38 percent, whereas freshwater vertebrate species declined by about 81 percent.[94] In Tunisia for example, rising temperatures could contribute to the loss of all food plants and breeding waterfowl and the disappearance of fisheries.[95]

SOCIAL COSTS

Land and environmental degradation have become the most significant drivers of displacement. The four root causes of displacement are: political instability, economic tension, ethnic conflict, and environmental degradation.[96] Recently, environmental refugees have become the single largest class of displaced persons. International migrants increased by 22 million between 2010 and 2015, partly driven by environmental degradation and food security.[97] In Africa, many people have become internally displaced or forced to migrate to other countries due to war, drought, and dryland degradation. Land degradation

[91]UNCCD, "Global Land Outlook."
[92]Selvaraju, "Implications of Climate Change for Agriculture and Food Security in the Western Asia and Northern Africa Region."
[93]Davidson, "How Much Wetland Has the World Lost? Long-Term and Recent Trends in Global Wetland Area."
[94]Dirzo et al., "Defaunation in the Anthropocene."
[95]Calhoun et al., "Temporary Wetlands: Challenges and Solutions to Conserving a 'Disappearing' Ecosystem."
[96]United Nations High Commissioner for Refugees, 1995. The State of the World's Refugees: In Search of Solutions. United Nations High Commissioner for Refugees. Geneva, Switzerland.
[97]UNCCD, "Global Land Outlook."

and climate change are likely to force 50–700 million people to migrate by 2050. By the turn of the century there may be one billion persons who have been "environmentally displaced from their original habitat."[98]

One of the least tangible impacts is the loss of cultural and aesthetic values associated with drylands. Land is often associated to the cultural identity, local knowledge, and dignity of many rural communities. Land degradation causes a loss of sense of place and spiritual connection to the land in indigenous peoples and local communities. Alienation of indigenous peoples from land often leads to the irreversible loss of accumulated knowledge on how to manage land. In most cases, land management practices based on indigenous and local knowledge have proven to be sustainable over long time periods and offer alternative models to the currently dominant human nature relationship.

[98]Lonergan, 1998. The role of environmental degradation in population displacement. Environmental change and security project report, 4(6), 5–15.

REGIONAL INITIATIVES, CHALLENGES, AND A FRAMEWORK FOR PROGRAM DESIGN

Restoration increases the supply and quality of ecosystem goods and services for individuals (private benefits) and society (public benefits). Just as land degradation has costs that go beyond just agricultural yield and income, restoration has many benefits that range from job creation to increase in biodiversity. Table 8 provides several restoration assessments in Africa and their benefits for some ecosystem services; however these benefits are still just a subset of overall benefits. Restoration also stimulates job creation and economic growth. Restoring 150 million hectares of degraded agricultural land could generate 85 billion USD in net benefits to national and local economies, provide 30–40 billion USD a year in extra income for farmers, and provide food for an additional 200 million people.[99] In the USA for example, restoration investment has resulted in the direct employment of 126,000 workers, which generates 9.5 billion USD in economic output annually.[100] Studies estimate that every dollar spent on restoring degraded forests yields between 7 to 30 dollars in economic benefits.[101] Failure to incorporate all the benefits of restoration leads to a much lower estimate of 0.7 trillion USD in net benefits and reduces the attractiveness of investing in it.[102]

The MENA region, which is one of the regions most affected by desertification, has recently started making some progress toward land restoration. The biggest restoration initiatives are currently targeting Africa, with some also in the MENA region. Due to security concerns and lack of data in the MENA region, restoration efforts have been lacking. At the same time, it should be noted that some countries in the region have successfully rehabilitated large areas, such as the western side of the Nile Delta in Egypt, along the Euphrates River in Syria, in the central Arabian Peninsula, and recently in the marshlands of southern Iraq, among others.[103] These success stories show that concerted efforts can indeed stop and even reverse desertification. Because of the important social, economic, political, and environmental consequences of desertification and climate change that are likely to shape the development of the Mediterranean, there are already a large number of organizations operating in the region with the aim of combating desertification.

[99]Economy, "The Global Commission on the Economy and Climate."
[100]BenDor et al., "Estimating the Size and Impact of the Ecological Restoration Economy."
[101]Verdone and Seidl, "Time, Space, Place, and the Bonn Challenge Global Forest Restoration Target."
[102]Ibid.
[103]Nielsen and Adriansen, "Government Policies and Land Degradation in the Middle East."

TABLE 8: ESTIMATED NET BENEFITS FROM NATIONAL-LEVEL RESTORATION ASSESSMENTS IN AFRICA

Restoration Activity	Country	Ecosystem Goods and Services Considered	Net Benefit	Study
Agroforestry	Kenya	Food production	**$111–175 per household year**	Franzel, 2005
	Kenya	Fuelwood and food production	**$94 per hectare over 2 years**	Swinkels and Franzel, 1997
	Rwanda	Food and timber production; carbon sequestration; erosion control	**$701–1,100 per hectare in Net Present Value (NPV) over 30 years**	Rwanda Natural Resources Authority (RNRA) and International Union for Conservation of Nature (IUCN), 2015
	Malawi	Crop and timber yields; carbon sequestration; watershed protection	**$1,904 per hectare in NPV over 30 years**	Republic of Malawi, 2017
Fodder shrubs	Mali	Reduced input costs	**$145–273 in NPV per community over 4 years**	Franzel, 2007
Improved woodlot management	Rwanda	Food and timber yield; carbon sequestration; erosion control	**$487 per hectare in NPV over 30 years**	RNRA and IUCN, 2015
	Tanzania	Timber and fuelwood production	**$543 per hectare in NPV over 5 years**	Franzel, 2005
	Uganda	Timber yields; carbon sequestration; watershed protection	**$754 per hectare in NPV over 30 years**	Ministry of Water and Environment (MWE) and IUCN, 2016
Community woodlands	Mawali	Timber yields; carbon sequestration; watershed protection	**$180 per hectare in NPV over 30 years**	Republic of Malawi, 2017
Natural regeneration	Uganda	Timber yields; carbon sequestration; watershed protection	**$828 per hectare in NPV over 30 years**	MWE and IUCN, 2016
Improved fallows	Zimbabwe	Food production and reduced input costs	**$9–41 per household per year**	Mudhara and Hildebrand, 2005
	Zambia	Fuel wood and food production	**$296 per hectare in NPV over 5 years**	Franzel, 2005
	Kenya	Fuelwood and food production	**$208 per hectare over 2 years**	Swinkels and Franzel, 1997

Source: WRI, 2017.[104]

International, regional, and local organizations understand the urgent need to restore forests and other lands. Several international agreements and commitments have been recently initiated in the past two decades that address desertification and land degradation. Some prominent examples are the United Nations Convention to Combat Desertification (UNCCD); Action against Desertification; Great Green Wall initiative; and

[104]World Resources Institute, "Roots of Prosperity. The Economics and Finance of Restoring Land."

the Bonn challenge (Box 9). By 2017, 39 countries committed to restore more than 150 million hectares through the Bonn Challenge.[105] Several regional initiatives have emerged to support countries' efforts to achieve the Bonn Challenge. Some of these initiatives are: the 20×20 Initiative in Latin America and Caribbean; AFR100 in Africa; ECCA30 in Europe, the Caucasus and Central Asia;[106] and ministerial roundtables in Latin America, East and Central Africa, and Asia Pacific.

BOX 9: KEY PLAYERS FIGHTING DESERTIFICATION

United Nations: The Interim Secretariat to Combat Desertification:
In 1977, the United Nations Convention to Combat Desertification (UNCCD) adopted a Plan of Action to Combat Desertification (PACD). The Interim Secretariat of the UNCCD provides affected countries with information and expertise. Countries affected by desertification implement the Convention by developing and carrying out national, subregional, and regional action programs. Criteria for preparing these programmes are detailed in the treaty's five "regional implementation annexes": Africa, Asia, Latin America and the Caribbean, the Northern Mediterranean, and Central and Eastern Europe.

Union for the Mediterranean:
Desertification, climate change, and their effects on agricultural production were at the heart of the Joint Declaration at the July 2008 Paris Summit of the Union for the Mediterranean (UfM). Attending Ministers also welcomed the progress made to date on reducing pollution in the Mediterranean waters. The UfM Secretariat's Water Agenda focuses on four main priorities: water governance, water and climate change adaptation, water demand management, and water financing.

Community of Sahel-Saharan States (CEN-SAD)/Sahara and Sahel Observatory (OSS):
After the ratification of the UNCCD, the Community of Sahel-Saharan States (CEN-SAD) was created in 1998 to strengthen an effective fight against desertification in the region. Its aim to develop a shared vision and a common program was based on South-South partnership and cooperation, with the Arab Maghreb Union (AMU). The Sahara and Sahel Observatory (OSS) whose experience in, and support for, implementation of the Convention spans more than 10 years of serving the region, its subregions, and their states, has offered to develop a regional community program to fight desertification, with the intention of reinforcing cooperation and sustainable development.

United Nations: Food and Agricultural Organization (FAO):
Evaluation and monitoring of desertification and drought processes are the primary ways in which FAO helps deal with desertification. One of FAO's basic functions is to collect and interpret global information on all aspects of the food, agriculture, forestry, and fishery sectors. In zones affected by desertification, these activities are particularly concerned with the natural resources used by the various sectors, their potential and vulnerability, and their state of degradation or conservation.

World Bank Partnership on Combating Desertification (WBPCD):
The WBPCD is financed by the World bank to create enabling environments to implement the Convention to Combat Desertification (CCD) in developing countries affected by desertification. The partnership supports the Secretariat of the United Nations Convention to Combat Desertification, Global Mechanism, International Fund for Agricultural Development (IFAD), United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), Food and Agriculture Organization (FAO) of the United Nations, subregional organizations, and countries in their activities to combat desertification.

Source: European Union, 2011.[107]

[105]World Resources Institute, "Roots of Prosperity. The Economics and Finance of Restoring Land."
[106]For more information see: https://infoflr.org/bonn-challenge/regional-initiatives/ecca30
[107]European Committee of the Regions, "The Relationship between Desertification and Climate Change in the Mediterranean."

REGIONAL AND NATIONAL INITIATIVES

Over the past two decades, many initiatives and projects, ranging in scale and thematic coverage, have addressed land degradation in MENA. Several programs and projects have been completed or are ongoing in the MENA region that focus on forest and agricultural land restoration (Table 9 and Table 10).[108] The tables below list a variety of such programs and projects; however, these are merely a sample of initiatives. These range from multi-country and long-term initiatives such as the Great Green Wall to smaller initiatives such as Acacias for All in Tunisia. Some of these are described in more detail to present the range and scale of different efforts in the region.

TABLE 9: LAND RESTORATION INITIATIVES IN MENA

Title	Implementers	Year Launched	Region/Countries
Great Green Wall initiative[109]	African Union	2007	Algeria, Burkina Faso, Benin, Chad, Cape Verde, Djibouti, Egypt, Ethiopia, Libya, Mali, Mauritania, Niger, Nigeria, Senegal, Somalia, Sudan, Gambia, The, and Tunisia
Updated rangeland strategy for Jordan[110]	Government	2011	Jordan
Economics of Land Degradation (ELD) Initiative[111]	UNCCD	2011	Global
Lebanon reforestation initiative[112]	USAID	2011	Lebanon
Acacias for all[113]	Acacias for all	2012	Tunisia
Program on desert ecosystems and livelihoods in the Middle East—North Africa region MENA-DELP[114]	World Bank and GEF	2013	Algeria, Egypt, Jordan, Morocco, Tunisia
Action against desertification[115]	FAO	2014	Burkina Faso, Ethiopia, Gambia, The, Niger, Nigeria, and Senegal
AFR100 (the African Forest Landscape Restoration Initiative)[116]	Multiple	2015	Africa
Agadir commitment[117]	Multiple	2017	Algeria, France, Iran, Lebanon, Morocco, Portugal, Spain, Tunisia, and Turkey

[108]Projects are more specific in nature and have defined activities to meet deliverables, whereas programs and initiatives focus on the coordination of several projects to meet a commitment.
[109]http://www.greatgreenwall.org/about-great-green-wall/
[110]http://moa.gov.jo/Portals/0/pdf/English_Strategy.pdf
[111]http://www.eld-initiative.org/
[112]https://www.lri-lb.org/
[113]http://challenges.openideo.com/challenge/climate-stories/stories/acacias-for-all
[114]http://www.oss-online.org/mena-delp/index.php/en/
[115]http://www.fao.org/in-action/action-against-desertification/overview/en/
[116]https://www.wri.org/our-work/project/AFR100/about-afr100
[117]https://www.unccd.int/sites/default/files/inline-files/9-Agadir-commitment-en.pdf

Title	Implementers	Year Launched	Region/Countries
Middle East North Africa Water and Livelihoods Initiative (WLI)—Regional[118]	CGIAR	2017	Egypt, Iraq, Jordan, Palestine, Tunisia
Pan-African Action Agenda on Ecosystem Restoration[119]	CBD, multiple	2019	Africa

TABLE 10: LAND RESTORATION PROJECTS IN MENA

Title	Implementers	Timeframe	Region/ Countries
Developing Sustainable Livelihoods of Agropastoral Communities of West Asia and North Africa[120]	ICARDA, IFPRI	1995–ongoing	Mashreq and Maghreb
Enabling Sustainable Dryland Management Through Mobile Pastoral Custodianship[121]	GEF, UNDP	2008–2012	Argentina, Benin, Burkina Faso, Iran, Kyrgyz Republic, Mali, Morocco
SIP: Stimulating Community Initiatives in Sustainable Land Management (SCI-SLM)[122]	GEF, UNEP	2008–2012	Ghana, Morocco, South Africa, Uganda
Rehabilitation of forest landscapes and degraded land with particular attention to saline soils and areas prone to wind erosion[123]	GEF, FAO	2008–2010	Iran
Adapting Conservation Agriculture for Rapid Adoption by Smallholder Farmers in North Africa[124]	ICARDA	2012–2015	Algeria, Morocco, and Tunisia
Enhancing food security across the Arab world[125]	ICARDA, IFPRI	2013–ongoing	Egypt, Tunisia, Morocco, Sudan, Syria and Jordan
Enhancing the resilience of farmers' livelihoods in Area C of Jenin, Nablus, Tubas, and Jericho Governorates through improved water availability and management[126]	FAO, government	2014–2016	West Bank
Identifying biodiversity-related success factors of ecological restoration projects[127]	Saint Joseph University	2017–ongoing	Lebanon

[118]https://wle.cgiar.org/project/middle-east-north-africa-water-and-livelihoods-initiative-wli-regional
[119]https://www.cbd.int/doc/c/274b/80e7/34d341167178fe08effd0900/cop-14-afr-hls-04-final-en.pdf
[120]http://www.fao.org/wairdocs/tac/y4953e/y4953e09.htm
[121]https://www.thegef.org/project/enabling-sustainable-dryland-management-through-mobile-pastoral-custodianship
[122]https://www.thegef.org/project/sip-stimulating-community-initiatives-sustainable-land-management-sci-slm
[123]https://www.thegef.org/sites/default/files/project_documents/07-04-08%2520PPG%2520Revised%2520Document_0.pdf
[124]http://www.cana-project.org/
[125]http://www.icarda.org/features/enhancing-food-security-across-arab-world#sthash.78SL3ol2.dpuf
[126]http://www.fao.org/emergencies/la-fao-en-action/projets/projet-detail/fr/c/237387/
[127]https://www.ser-rrc.org/project/identifying-biodiversity-related-success-factors-of-ecological-restoration-projects/

Great Green Wall initiative

One of the largest initiatives to combat desertification is the Great Green Wall movement across Africa. The Great Green Wall is envisioned to be an 8,000 km natural wonder across the entire width of Africa. This semiarid region of western and north-central Africa extends from Senegal to Djibouti. It forms a transitional zone between the arid Sahara Desert to the north and the belt of humid savannas to the south (Figure 17). Other objectives include building climate resilience for local communities, improving food security, introducing green jobs, and contributing toward stability and peace. While it is not an initiative that mainly targets the MENA region, it has recently expanded to some North Africa countries and will positively affect most of MENA with its long-term transboundary impacts. Once complete, the wall will be the biggest structure on Earth and about three times the size of the Great Barrier Reef.

FIGURE 17: GREAT GREEN WALL BOUNDARY

Source: www.greatgreenwall.org

Launched in 2007 with 10 African countries on board, the initiative has now expanded to 21 countries. The wall is no longer envisioned as a narrow band of trees along the southern edge of the Sahara, a nearly 8,000 km–long, 15 km–wide corridor from Senegal in the west to Djibouti in the east. The plan now is to surround the Sahara with a wide belt of vegetation, trees, and bushes greening and protecting an agricultural landscape. The new vision engages all the countries surrounding it, including Algeria and others in North Africa, not just the 11 original Sub-Saharan countries of the Sahel.

A decade in and roughly 15 percent underway, the initiative is already bringing life back to Africa's degraded landscapes at an unprecedented scale, providing food security, jobs, and a reason to stay for the millions who live along its path. Results so far include: 12 million drought resistant trees planted in the last decade in Senegal; 3 million hectares of land rehabilitated through local practice in Burkina Faso; 15 million hectares and 5 million hectares of degraded land restored in Ethiopia and Nigeria, respectively; and 5 million hectares of land restored, delivering an additional 500,000 tons of grain per year, in Niger.

African restoration initiative (AFR100)

Another Africa-wide initiative is the AFR100 (the African Forest Landscape Restoration Initiative), which is a country-led effort to bring 100 million hectares of deforested and degraded landscapes across Africa into restoration by 2030. The objective of the African Restoration Initiative (AFR100) is to facilitate the first-ever African regional initiative on forest landscape restoration with a collective goal to restore 100 million hectares of degraded forest landscapes by 2030. The initiative engages national governments, regional institutions, public and private sector partners, and international development programs that will work together to restore productivity to deforested and degraded landscapes to improve livelihoods. Commitments announced through AFR100 also support the Bonn Challenge, a global target to bring 150 million hectares of land into restoration by 2020 (Figure 18).

FIGURE 18: AFR100 COMMITMENTS

Source: www.afr100.org

Middle East North Africa Water and Livelihoods Initiative (WLI)—regional

The Water and Livelihoods Initiative (WLI), completed in 2018, aimed to improve livelihoods of rural households and communities in Egypt, Iraq, Jordan, Lebanon, Palestine, Tunisia, and Yemen. The Middle East Water and Livelihoods Initiative (ME-WLI) began in 2009 and was funded by the United States Agency for International Development (USAID), and managed by the International Center for Agricultural Research in the Dry Areas (ICARDA). The goal of this project is to improve the livelihoods of households and communities in selected countries by increasing economic, social, and educational opportunities through addressing key priority water and land management issues identified in each country.

Interventions are aimed to increase crop productivity; awareness of sustainable practices; rural income; and climate resilience. The initiative comprised of a variety of biophysical and socioeconomic related activities geared toward the development of improved technologies and innovation packages to address critical development challenges; as well as building local, national, and regional capacity to ensure sustainable adoption and utilization of proposed solutions. Specifically, the initiative targeted: (1) improvement technologies and management practices; (2) agricultural sector productivity and food security training; (3) forming and encouraging enterprises, producer organization, and other trade and business associations; and (4) improving climate resilience.

Program on desert ecosystems and livelihoods in the Middle East—North Africa region (MENA-DELP)

The MENA-DELP program employs an integrated approach to land management in its national projects and enables knowledge sharing between countries. The program comprises of six projects: five national projects (Algeria, Egypt, Jordan, Morocco, and Tunisia) and one regional project. The national projects include a variety of themes, from ecotourism to agriculture and livestock production, but they all seek to improve the sustainability of the investments by using an integrated approach to ecosystem management. Emphasis is also placed on participatory approaches, capacity building, and the use of local knowledge. The regional project entitled "Coordination and Knowledge Sharing Project on Livelihoods and Desert Ecosystems" under the program is funded by GEF through the World Bank and was implemented from 2013 to 2017. The aim of the regional project is to support the national projects under the program. It aims to strengthen networks between selected organizations in these countries through the sharing of experiences and knowledge on sustainable management of desert ecosystems.

The national projects are based in Algeria, Egypt, Jordan, Morocco, and Tunisia, focusing on topics such as ecotourism, agriculture, and livestock production. The project in Jordan is called the Badia Ecosystem and Livelihood project which aims to support sustainable livelihoods and improve ecosystem services using participatory approaches in certain parts of Badia, in Jordan. There are two projects in Tunisia, one on ecotourism and desert biodiversity conservation, which focuses on ecotourism and community development in three national parks in Tunisia, and another project on management of oasis ecosystems, which aims to improve the management of six oases and diversify livelihoods. The Solidarity and Integrated Agriculture Project in Morocco on the other hand promotes and disseminates the outputs of national agronomic research related to land conservation and biodiversity preservation measures through eight inclusive, solidarity agricultural projects, in the Moroccan greening plan (Plan Maroc Vert).

Developing Sustainable Livelihoods of Agropastoral Communities of West Asia and North Africa

The project entitled "Developing Sustainable Livelihoods of Agropastoral Communities of West Asia and North Africa" program is built on Mashreq/Maghreb project (phases I, II, and III). The Mashreq/Maghreb project began in 1995 and is now in its third phase. Entitled "Developing the Sustainable Livelihoods of Agropastoral Communities of West Asia and North Africa (Mashreq/Maghreb III)," the third phase is working to improve the livelihoods of poor farmers in low rainfall areas of North Africa and West Asia. The project works with eight countries—Algeria, Iraq, Jordan, Lebanon, Libya, Morocco, Syria, and Tunisia. In these areas, researchers are working with

farmers and local communities to develop new technical, institutional, and policy options. These will improve people's livelihoods by boosting the productivity of livestock, crops, rangelands, and water. It also emphasizes the need to conserve natural resources.

The overall goal is the development of productive and sustainable agropastoral systems that conserve the resource base and support rural livelihoods in the dry areas of the MENA region. The components of the project include: consolidating the community approach; implementing community development plans (CDPs); applied and adaptive research themes including water harvesting, alternative crops, communal management of rangeland resources, and risk and drought mitigation; evaluation of the return to investment in the dry areas; development of social environmental and economic indicators; and regional integration and capacity building. Twelve communities from the eight MENA countries (Algeria, Iraq, Jordan, Lebanon, Libya, Morocco, Syria, and Tunisia) participated to implement the project, together with eight national research institutions, 176 researchers, extension services, and development agents.

Adapting conservation agriculture for rapid adoption by smallholder farmers in North Africa: Conservation Agriculture for North Africa (CANA)

The CANA project aims to test, develop, and upgrade conservation agriculture in North Africa. The CANA project aims to promote Conservation Agriculture (CA) by smallholder farmers in North Africa to reduce land degradation and increase productivity, profitability, and sustainability of the crop/livestock systems in the region. The project has been addressing the constraints to adoption of CA systems by small-scale and medium-scale farmers (smallholders); developed low-cost machinery and adapted cropping systems; and upgraded the CA capacity of the national agricultural research systems. Furthermore, a participatory research, networking, and knowledge sharing among the three core countries (Algeria, Morocco, and Tunisia) and Australian partners will be implied. The expected results from this partnership will spill over to other African and Middle Eastern countries.

Enhancing food security across the Arab world

The Enhancing Food Security in Arab Countries project is taking innovative approaches to address food security. The project targets six countries: Egypt, Tunisia, Morocco, Sudan, Syria, and Jordan. It promotes multiple technology transfer methods, pilot testing in farmers' own fields, and integrated capacity-building components. The project is providing practical solutions to improve wheat production and enhance food security and sustainable agriculture in the region.

The project has generated substantial benefits to farmers from improved varieties and agricultural practices. In Egypt, comparative demonstrations on raised-bed planting technology conducted over two seasons resulted in an average 30 percent increase in wheat yield, 24 percent saving in irrigation water, and 72 percent increase in water-use efficiency over farmer technology. On-farm demonstrations of conservation agriculture based on the no-till system were established on 10 farms in Jordan. Conservation agriculture techniques resulted in generally higher biological yields (6.7 ton/ha versus 3.5 ton/ha) and grain yields (2.1 ton/ha versus 1.8 ton/ha) than conventional tillage. The project has also targeted capacity-building activities during the year, despite difficulties due to unrest in the region. A total of 9,240 participants attended a variety of capacity-building events. Over 7,100 farmers, researchers, policy makers, and other participants attended 178 farmers' field

schools, while over 720 participants attended in-country training courses or symposiums. Regional activities also took place, such as a farmers' traveling workshop, which involved farmers, extension agents, and researchers from the six countries.

Lebanon Reforestation Initiative

The Lebanon Reforestation Initiative (LRI) was launched in 2010 and aims to regenerate the forests and empower communities across Lebanon. LRI is a project funded by the U.S. Agency for International Development (USAID) and implemented by the U.S. Forest Service, was established in 2010 to undertake an ambitious program of technical assistance and institutional support on sustainable forestry practices and wildfire management in economically depressed and environmentally degraded regions of Lebanon. LRI aspires to promote long-term sustainable reforestation across Lebanon through improving the connectivity of forests, giving wildlife a safer habitat, and empowering communities to work together to take positive action as stewards and protectors of their forests and environment.

The initiative has successfully planted many trees, engaged the community, and developed a web-based platform that provides data for practitioners. The LRI has planted more than half a million native tree species on more than 700 hectares throughout all regions of Lebanon. The project has also dramatically improved survival rates of planted tree seedlings—on average between 70–90 percent after three years, compared with a previous national average of about 25 percent. As a part of the LRI project, the U.S. Forest Service has developed and implemented models of effective community engagement that ensure sustainable landscape restoration projects are supported locally and directly benefit communities. The program has also developed a Geographic Information System (GIS)–based, web-mapping platform that allows national policy makers, forestry practitioners, the private sector, and other donors to identify and coordinate priority areas for landscape restoration nationwide, and that provides critical biophysical and national reforestation data previously unavailable publicly.

Updated National Rangeland Strategy for Jordan

The Updated National Rangeland Strategy uses a holistic approach to land restoration. The National Rangeland Strategy was developed in 2001 and updated in 2013. The strategy builds on the ancient tradition of Hima, which integrates natural resources, community life, ethics, animal welfare, and more. It encourages communities to build their own institutions to manage the rangelands. The Hima concept mirrors the landscape restoration approach which is promoted globally by key stakeholders in combating land degradation. Its main goals are: (1) rangelands sustainable development and management; (2) improvement of social and economic conditions for livestock breeders and pastoral communities taking into consideration gender issues; (3) enhancement of capacity building (training and awareness); (4) monitoring and evaluation of rangeland status; and (5) engagement of local communities in sustainable rangeland development and management.

Some prominent results from the various projects under the strategy include ecological benefits, increased income, and reduced conflicts. After one year of activities in the Bani Hashem community in central Jordan, biodiversity benefits have already been observed. Indigenous floral species are back, and shrubs and grasses are regenerating. A total of 36 native plant species were recorded on the site, mainly in the area that receives

the highest rainfall. Furthermore, tribal conflicts over natural resources are reduced with the Hima system. The approach builds on the capacity of the local community and increases the involvement of different groups, including women. They play a major role in improving their livelihoods through securing their access and management rights and building relationships with government institutions. However, nationwide results of the Updated Rangeland Strategy cannot be observed yet, since due to the political situation in the region, the government has dedicated the budget to security and social issues.

Acacias for All (Tunisia)

Acacias for All is a cooperation of 483 women launched in 2012 and based in Tunisia. Acacias for All aims to change the agricultural sector in the Arab Maghreb subregion (with a focus on Tunisia, Algeria, and Morocco) by introducing a new holistic farming approach to fight desertification. The premise of the organization is to shift agriculture from commonly cultivated and water-intensive crops such as almonds, barley, and wheat to alternative seeds and trees that are more sustainable. The organization also promotes new and sustainable farming techniques and the formation of cooperatives so that they can manage planting, training, and commercializing.

Acacia tree plantings have been the focus, which have huge ecological and economic benefits. Acacias for All plants acacia trees as they: (1) revitalize the land and require less water than traditionally cultivated crops; (2) create a greenbelt to prevent desertification; and (3) provide steady income throughout the year. Since its inception, over 10,000 trees have been planted with school children and women. The women are trained to collect acacia gum from the trees and sell it to Fairtrade industries, which provides an income of 950–1,500 USD annually for each woman. Through the reforestation program, training, and coaching, Acacias for All offers residents the opportunity to restore their environment, fight against desertification, and generate income, particularly for women who are most vulnerable to the effects of climate change.

WORLD BANK PROJECTS RELATING TO SUSTAINABLE LAND MANAGEMENT IN MENA

Several World Bank projects have addressed land degradation in MENA. Table 17 in Appendix A describes some of the World Bank executed, completed, and ongoing projects on sustainable land management in MENA countries.[128] Most projects were at least five years long, and covered various themes such as agriculture, forestry, livestock, and biodiversity development and conservation. Most projects address many multi-sectoral issues, so land management interventions are usually coupled with government capacity building, livelihood development, and research efforts. The majority of the project interventions are related to capacity building of agriculture and forest producers, community-based natural resource management, improving infrastructure, developing biodiversity conservation sites, enabling producer groups, and promoting ecotourism.

[128]This list is not exhaustive but is provided to show the range of select projects in the region.

CHALLENGES FOR RESTORATION INVESTMENTS AND EXISTING PROJECTS

BARRIERS FOR FINANCING RESTORATION

Restoration investments in MENA, especially from nongovernmental sources, fall short considering the extent of degradation in the region. There are two major findings regarding restoration financing in MENA. First, that restoration projects, especially large-scale ones are generally lacking. While there are a few initiatives that were launched in the past few years, they are nowhere close to what is needed to restore lands in the region. Secondly, most of the funding for these projects has come from public sources, signaling a huge gap in private sources of restoration finance.

Investments to restore degraded lands are generally lacking due to the undervalued and longer term benefits of restoration. Upholding the targets set by the Bonn Challenge of restoring 150 million hectares of degraded lands could create 84 billion USD in annual material benefits.[129] Benefits include numerous environmental, social, and economic benefits, from carbon sequestration to job creation and improved agriculture productivity. However, the investment needed to meet this goal is currently not enough globally and especially not in the MENA region. It is estimated that approximately 350 billion USD is needed for conservation and restoration, but only 50 billion USD is available and 80 percent of that comes from public sources.[130] Private investment is only about 10 billion USD a year. Financial systems must internalize the environmental and social costs of restoration projects to allow for restoration to be financed at scale. Investor interest in a specific restoration project will depend on what benefits are generated and to whom they accrue. For example, projects that generate only public benefits such as carbon and biodiversity will not be interesting to private investors, who prioritize financial returns. Many restoration projects generate benefits that are difficult to monetize and capture, which is partly why public investment, with its focus on social and environmental benefits, has dwarfed private investment in restoration to date.

Barriers for accessing public finance include small environmental budgets and inaccessibility to climate finance. In response to the growing urgency of climate change, several multilateral funds have been established to finance climate solutions, such as the Amazon Fund (1.7 billion USD), the Forest Investment Program (722 million USD), and the United Nations Convention to Combat Desertification (UNCCD) Land Degradation Neutrality Fund (300 million USD).[131, 132] These are the select few funds that focus on land use and forests, as most climate finance is aimed at energy and transportation.[133] For instance, public climate finance totaled 128 billion USD in 2012, land-use projects accounted for just 7 billion USD of that total, and only a fraction of that was for restoration.[134] Restoration proposals face barriers including unclear revenue streams, lack of investment track records, and risk of project failure. Additionally, the funds each have different rules, requirements, and procedures, resulting in high transaction costs. Another issue is that while governments have funded restoration projects, the money often comes from small environmental budgets. Environmental ministries often have smaller budgets than other government bodies, where restoration also makes up a small fraction of environmental budgets. Governments do not

[129]IUCN, "Enhancement of Natural Capital through Forest and Landscape Restoration (FLR)."
[130]Credit Suisse, WWF (World Wildlife Fund), and McKinsey and Company, "Conservation Finance: Moving Beyond Donor Funding toward an Investor-Driven Approach."
[131]UNCCD (United Nations Convention to Combat Desertification), "LDN Fund Officially Launched."
[132]CFU (Climate Funds Update), "Which Climate Funds Focus on REDD+Finance?"
[133]Denier et al., "The Little Sustainable Landscapes Book."
[134]Buchner et al., Global Landscape of Climate Finance 2015.

realize the wide-ranging scope of restoration and fail to coordinate with different ministries such as agriculture and water, which usually means that restoration projects may fail to be funded.

Private restoration financing is lacking because most restoration projects are too small or require a long investment time horizon and have many risks associated with them. Capital is usually concentrated in large funds, so a 5 billion USD fund has less incentive in making a 5 million USD investment because of transactions costs. Even though restorations projects with good financial returns exist, there is no standard medium or process to find them, whereas multiple avenues exist for industries such as transport and energy.[135, 136] Another issue has to do with the amount of time it takes to realize financial gains in restoration projects, especially reforestation projects. The long timeframe can limit investor interest as returns in the near term are valued more than returns later. Future returns also carry many financial, political, and environmental risks, and investors view these risks subjectively. So, for restoration to attract more private capital, it must not only be attractive on an absolute basis, but also be more attractive than other investments being considered. Private investors also typically use higher discount rates when evaluating restoration investments due to high opportunity costs and perceived risks, as restoration is usually a new area for most investors. Given a high discount rate and a back-loaded cash flow profile, restoration investments are often viewed by private investors as having poor risk-adjusted returns.

CONTEXTUAL BARRIERS

Besides barriers for investments, there are also contextual factors that are important to consider for interventions to work. Selecting an appropriate mix of interventions and mechanisms is fundamental in promoting long-lasting sustainable land management. A given instrument will not work the same everywhere and thus depends on specific national and local conditions. There are several conditions for action to be successful in terms of fostering adoption of more sustainable land management: the cultural, economic, financial, legal, political, social, and technical environment all need to be aligned to ensure that one or several complementary options can be implemented successfully. For instance, adoption of Natural Resource Management (NRM) practices is usually constrained due to limiting factors such as property rights over land and input access.[137] Interventions should be implemented using socially relevant pathways for successful adoption, which can be identified using stakeholder consultations and engagement processes. Approaches involving stakeholders should ensure that the most economically desirable option is compatible with existing economic mechanisms, technically and legally feasible, and environmentally and socially acceptable.

One of the biggest lessons learned from projects already implemented is that they have often been too top-down in their approach. The increased focus on local participation in project planning is so important because previous attempts to combat desertification—usually coordinated by international organizations—failed to consider the views, perceptions, and capacities of local people. Traditionally, outside experts from concerned international organizations initiated the planning process for implementation of national and regional action programs by defining objectives, activities, and expected outputs. This was then followed by a visit to the area to consult local authorities, inform them of the plan, and invite the community to help in executing projects. Local communities, on the

[135]Suisse, "McKinsey, 2016."
[136]For an example of a venue in which technology entrepreneurs can pitch ideas and attract capital investment, see Silicon Valley Open Doors (http://www.svod.org)
[137]Stevenson et al., "Farmer Adoption of Plot-and Farm-Level Natural Resource Management Practices: Between Rhetoric and Reality."

other hand, have valuable experience and a special appreciation of their own environment. When the responsibility for natural resource management is taken away from them, their use of land and other natural resources can become highly inefficient. The result is often land degradation. Thus, participatory development recognizes the rights of local communities over their resources, granting them a greater stake than anyone else in improving agricultural productivity while ensuring the long-term ecological balance of their fragile lands.

On the micro level, some challenges include inclusivity, training and information, and monitoring of community-based land management. While most restoration projects have been moderately successful, there are some important lessons to consider. In particular, marginalized groups such as women and the landless poor should be given more attention. Forest micro plans, for instance, could be used to identify and to help address the specific needs of these groups. Additionally, although experience has shown that local institutions can be successful in managing forests, community members need to be provided with adequate training and information, property rights, and autonomy to make financial decisions. Lastly, monitoring and enforcement of land-related rules are particularly important for community management to be effective. Thus, communities need to agree on certain rules and regulations, and mechanisms need to be established to enforce those rules.[138]

Similarly, World Bank projects on land management in MENA offer lessons learned relating to project design, information access to government agencies, and financial and market access for beneficiaries. World Bank projects completed in the past two decades provide several lessons learned that are relevant for the planning stages, coordination, and beneficiaries (Table 17). Projects acknowledge that some MENA countries are low income, and conflict affected, so a simple project design that promotes active participation of the beneficiaries should be developed. Additionally, land tenure complexities should also be addressed at the time of project design. Another commonly cited problem has to do with lack of coordination between government bodies, which could be mitigated by making information accessible to all parties and focusing on local-level coordination early because development may be faster at the local level than at the national level. For the beneficiaries, factors that were often ignored or needed improvement had to do with finance and market access. Addressing constraints for smallholder farmers to access finance is at the core of the sustainability and replicability of projects. A deeper focus on access to finance and markets, as well as market linkages, should be an indispensable element of implementing livelihood interventions.

THE P.R.I.M.E. FRAMEWORK AND ITS ADAPTATION TO LAND

Land degradation issues are difficult to address without also addressing the needs of households who live on those lands.[139, 140] Degradation and poverty are often interrelated but are hard to address simultaneously. Poverty combined with internal and/or external change factors—population growth, land races, and external interventions—can possibly set off self-perpetuating processes of land degradation. If poor farmers are given cash transfers that enable them to increase cultivation on their lands, it could lead to further degradation, which in the long term can harm agricultural yield and exacerbate poverty. Hence, pathways out of poverty should have a conservation focus so that poverty is reduced sustainably, and the quality of the farmers' lands is preserved.

[138]Shyamsundar and Ghate, "Rights, Rewards, and Resources: Lessons from Community Forestry in South Asia."
[139]Colfer, Elias, and Jamnadass, "Women and Men in Tropical Dry Forests: A Preliminary Review."
[140]World Bank, "Forest Action Plan FY16-20 (No. 106467)."

One of the main objectives of many land restoration projects is to also reduce poverty. This is especially the case for most World Bank projects whose mission is to end poverty. Therefore, land restoration projects often focus on livelihood development along with restoring degraded land, especially since poverty and degradation are interrelated. Many projects focus on sustainable land management practices that can increase productivity so that land is restored, and beneficiaries see an increase in income. But, to achieve both those outcomes, some other factors need to be addressed as well. For instance, some of the most common challenges and lessons learned from restoration projects in MENA have to do with land rights, financial and market access, and preserving ecosystem functionality. Ignoring these factors can result in project outcomes being unsuccessful and unsustainable.

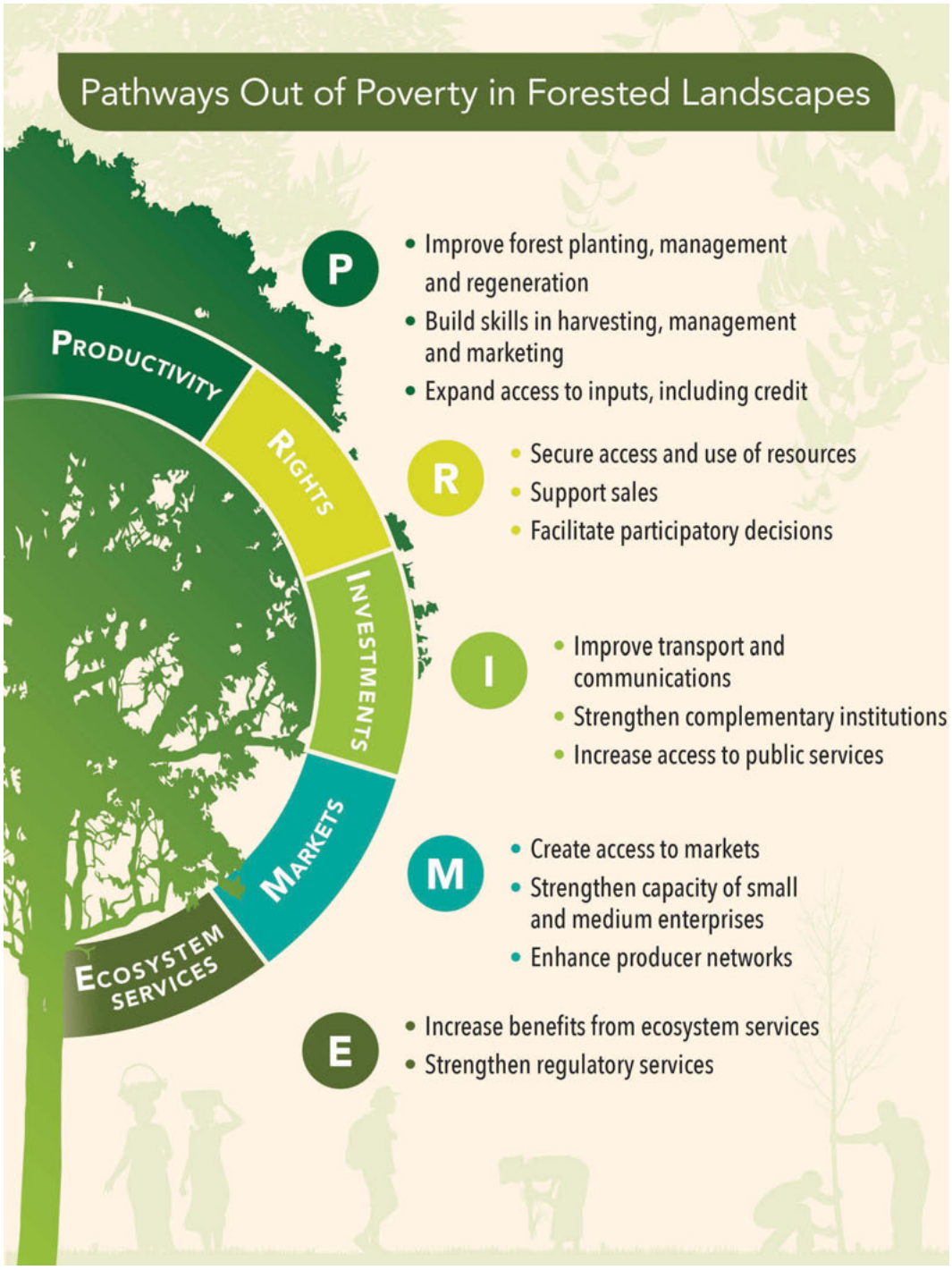
P.R.I.M.E. is a broad framework that conceptualizes how forests, or land in general, can contribute to poverty reduction. The PRIME. framework is a tool that considers the land-related constraints that trap people in poverty. The P.R.I.M.E. framework proposes fives pathways for prosperity, which are increasing productivity of land and labor (P); strengthened rights over land (R); complementary investments in infrastructure and institutions to reduce poverty (I); increased market access (M); and mechanisms that enable the flow of land-based ecosystem services to those dependent on it (E) (Figure 19).[141] These pathways are also reported as challenges in many land restoration projects. To use it as a tool for evaluating land restoration projects, two important adaptations are made to the framework. First, although the framework was originally developed for forest landscapes, it can be adapted to the broader context of land, which encompasses forested, agriculture, and grazing lands. Second, while the framework proposes using land as a tool for poverty alleviation, a complementary goal can also be restoration. For this purpose, the type of land and its level of degradation are very important when using PRIME. The framework is only suitable in cases where land is not yet severely degraded and where using sustainable land management can both rehabilitate land and result in increased income.

Resource productivity (P) should be addressed sustainably and considering context. Growth in land and labor productivity is integral to development.[142, 143] Land and labor productivity can be increased in multiple ways, depending on the scale at which the beneficiaries use the land, and the scale of the intervention itself. In contexts where land is vulnerable to degradation, productivity can be increased by training farmers on sustainable agriculture practices, for instance. Improved productivity assumes the same type of land use is continued, and can refer to the adoption of more sustainable practices to improve agricultural yields and livestock production, and afforestation/reforestation to control water flows, etc. Productivity boosting interventions should therefore be context specific and encourage the long-term well-being of those lands.

A second strategy is to increase the wealth of the poor by strengthening their rights (R) over land. Secure rights can reduce uncertainty over resource access and allow households to make longer term investments.[144, 145] Land redistribution from wealthy owners of large farms to land-poor farmers, tenants, or farm workers can foster economic growth, poverty reduction, and gender equity if managed well and supported by strong policies and capacity development. Recently, community-based land management has increased the

[141]Shyamsundar et al., Understanding Forests' Contribution to Poverty Alleviation: A Framework for Interventions in Forested Areas.
[142]Irz et al., "Agricultural Productivity Growth and Poverty Alleviation."
[143]De Janvry and Sadoulet, "Agricultural Growth and Poverty Reduction: Additional Evidence."
[144]Meinzen-Dick, Kameri-Mbote, and Markelova, "Property Rights for Poverty Reduction?"
[145]Martin, "Reforming Forest Tenure: Issues, Principles and Process."

FIGURE 19: THE PRIME FRAMEWORK



Source: Shyamsundar et al., 2018.

accountability and ownership of communities over land use.[146] This has happened through power-sharing agreements with the state, and increased legal access and decentralization within national agencies.[147] Community-based forest management is a form of decentralized management that seeks to improve the quality and stock of forests by strengthening user rights and allowing users to manage village forests collectively. Evidence on community forestry in

[146]Gilmour, Forty Years of Community-Based Forestry: A Review of Its Extent and Effectiveness.
[147]Chhatre and Agrawal, "Trade-Offs and Synergies between Carbon Storage and Livelihood Benefits from Forest Commons."

South Asia suggests that it is associated with better forest quality compared to areas without community forestry.[148] Furthermore, investing in resource rights has implications for many of the most marginalized people, including women and indigenous communities.[149, 150, 151] A critical element of success is securing the rights of women over land. Such rights need to be set out in law in countries where this has not happened, and publicized, explained, and implemented in places where legal changes have not made much difference to everyday practices.

Poverty reduction will not be possible without investments (I) in institutions that govern land use and public infrastructure and services, such as transport, electrification, and health facilities. Investments in complementary institutions encompasses a wide range of areas. Some examples of these areas are access to credit, information services, infrastructure development, access to basic services, and institutional capacity building. Complementary investments in these areas significantly reduce poverty. For example, poverty in remote rural areas is partly a result of limited access to public services, which can inhibit the growth of market-oriented activities.[152, 153]

Creating access to markets (M) is a well-established conduit for jobs and income generation in rural areas. Communities have long used land resources for subsistence purposes and some have also connected to markets. Improving market linkages can be very helpful, especially for those that are disconnected from markets. Market access was also identified as a gap by many completed restoration projects in MENA. For timber for example, gaining certification and access to export markets are important economic strategies. For this approach to succeed, more needs to be done to strengthen small and medium enterprises (SMEs) by increasing their access to credit, technologies, and marketing networks.

A final opportunity is to strengthen the flow of benefits from ecosystem services (E) to the land-dependent poor. Ecosystem services can enhance the productivity of land, improve environmental quality, and reduce risks.[154, 155, 156] Over the last decade, there have been attempts to better manage ecosystem services by enhancing their value through policy instruments such as payments for ecosystem services (PES), carbon markets, and investments in eco-tourism businesses.[157, 158, 159] PES has been developing rapidly under the framework of the Convention of Biological Diversity (CBD) supported by Millennium Ecosystem Assessment and environmental economics. While there are many critical non-monetary services provided by land, this framework focuses on strategies to channel the demand for ecosystem services into direct income gains for the poor.

MAPPING OF PROJECTS USING THE PRIME FRAMEWORK

To determine whether project components aligned with PRIME, the decision criteria listed in Table 11 were applied. For example, for an intervention to be counted under "R," rights had to be strengthened over land by enabling land user groups or

[148]Shyamsundar and Ghate, "Rights, Rewards, and Resources: Lessons from Community Forestry in South Asia."
[149]Agarwal, "Gender and Forest Conservation: The Impact of Women's Participation in Community Forest Governance."
[150]Colfer, Elias, and Jamnadass, "Women and Men in Tropical Dry Forests: A Preliminary Review."
[151]World Bank, "World Bank Annual Report 2016."
[152]Kraay and McKenzie, "Do Poverty Traps Exist? Assessing the Evidence."
[153]Barbier, "Is Green Growth Relevant for Poor Economies?"
[154]Miura et al., "Protective Functions and Ecosystem Services of Global Forests in the Past Quarter-Century."
[155]Munang et al., "The Role of Ecosystem Services in Climate Change Adaptation and Disaster Risk Reduction."
[156]Renaud, Sudmeier-Rieux, and Estrella, The Role of Ecosystems in Disaster Risk Reduction.
[157]Millenium Ecosystem Assessment, "Ecosystems and Human Well-Being."
[158]Bulte et al., "Payments for Ecosystem Services and Poverty Reduction: Concepts, Issues, and Empirical Perspectives."
[159]Alix-Garcia and Wolff, "Payment for Ecosystem Services from Forests."

collectives. However, the mere inclusion of community members in the design, implementation, or monitoring process of a project component did not count, even if it may have de facto strengthened their rights over land. Under "I," projects counted only if the regional complementary investment was supporting people's livelihoods in forest or agricultural landscapes, for example, by improving access roads or improving institutional capacity related to land management. "M" interventions included actions aimed at enhancing market access, e.g., through marketing and logistics support, and value-addition activities. Market infrastructure investments were excluded as they were captured under "I." Lastly, for "E," interventions such as payment for ecosystem services (e.g., REDD+) or developing ecotourism initiatives were included.

TABLE 11: CRITERIA FOR APPLYING PRIME FRAMEWORK

Criteria	Include	Exclude
Productivity	The intervention boosts productivity through enhancements to land, machinery or labor. Examples: Training individuals or communities in sustainable land management (e.g., planting, harvesting, monitoring), and/or agroforestry production. Providing machinery and/or technology to enhance productivity, such as irrigation systems, seedlings, or fertilizer.	The intervention does not focus on enhancing land productivity.
Rights	Intervention strengthens formal or informal rights (including decision-making processes) over land. Examples: Granting individuals and/or communities land/output ownership and/or user rights. Strengthening inclusive land user groups.	Intervention only includes participatory component in project design, implementation and/or monitoring.
Investments	Intervention provides complementary investments in institutions, infrastructure, and public services at the regional level that support the agriculture and/or forestry sector. Examples: Improving the functioning of forestry and agriculture institutions, such as reducing bureaucratic/legal hindrances and streamlining of regulatory processes for small-scale enterprises or creating institutional mechanisms to enhance land-based economic activities. Introducing safety net programs tied to remote landscapes. Improving rural connectivity, including transport and IT infrastructure to enhance agriculture and forest livelihoods. Increasing access to credit to support land management, agroforestry or the production of Non-Timber Forest Products (NTFPs).	Intervention supports broad-based institutional reform, such as the development of a national forest sector strategy or land-use plan.

Criteria	Include	Exclude
Markets	Intervention enhances market access through marketing and logistics support or value addition Examples: Introducing certification schemes for timber or NTFPs. Developing new/additional forest or agricultural products and/or adding value to existing products. Creation of producer networks and cooperatives.	Intervention improves infrastructure access to markets, such as through roads, as this is included in "I."
Ecosystem services	Intervention enhances the returns from ecosystem services in an equitable manner, including monetary, such as REDD or other carbon sequestration payments, as well as nonmonetary income from ecosystem assets or services. Examples: Introducing payment for ecosystem services. Developing nature tourism initiatives that benefit local poor. Training on managing land-based ecosystem services.	Intervention is not livelihoods oriented, i.e., if it only has a conservation focus.

Source: Shyamsundar et al., 2018.

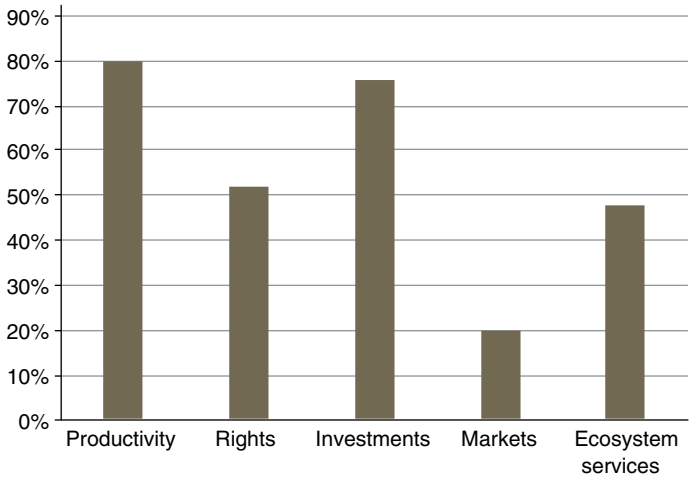
The average land restoration project in MENA covered about three PRIME themes. About 44 percent of the projects on land restoration in MENA covered three PRIME themes, with most of the others covering between two or four themes (Table 12). No projects covered all five themes. Additionally, every project covered at least one of the themes and only 8 percent covered only one. Since the PRIME themes are interrelated, it is expected that most projects would address more than one theme. For instance, projects that mainly focus on increasing productivity (P) will also allocate funds on improving infrastructure and information access which are complementary investments (I).

While projects covered multiple PRIME themes, most of these were productivity (P) and complementary investments (I), with very few addressing markets (M). Most of the projects in MENA addressed productivity (P) and complementary investments (I) as they featured in 80 percent and 76 percent of projects, respectively (Figure 20). Rights (R) and ecosystem services (E) were both addressed in about half the projects. The theme addressed the least in projects was markets (M), which was only addressed in 20 percent of the projects. These results are not so surprising, as most projects traditionally focus on increasing productivity and complementary investments. Additionally, complementary investments is a broad theme as it covers many areas such as institutional capacity, access to basic services and credit, and infrastructure improvement, so it is bound to be included. The results point to a gap in investment on the other three themes—rights, ecosystem services, and especially markets.

TABLE 12: PRIME THEMES ADDRESSED BY PROJECTS

PRIME Themes per Project	Share of Projects
1	8%
2	28%
3	44%
4	20%
5	0%

FIGURE 20: PROJECTS COVERING DIFFERENT PRIME THEMES



Land degradation, especially in MENA, has overwhelming human and ecological costs and requires carefully planned actions to reverse it. Sustainable land management requires a holistic approach to strengthen collaboration among government ministries and channel financial support from climate funds, environmental defense funds, and sustainable development funds into restoration initiatives. Furthermore, lessons learned from previous efforts and constraints from the PRIME framework should be considered when designing projects as well. Given the strong political impetus for restoration, now is a critical moment to accelerate restoration implementation on the ground. Any postponed action or inaction is the most expensive course in the long run—not only in terms of money, but also in the form of human progress.

SUCCESS STORIES AND RECOMMENDATIONS

Restoration projects from different regions of the world have proven to be extremely beneficial and offer lessons for restoration work in MENA. As discussed in Chapter 2, land degradation and desertification have had immense wide-ranging costs globally, and have resulted in food insecurity, poverty, displacement, and lower biodiversity. Over the past few decades, countries all over the world have taken serious measures against land degradation, where some of them have proven to be model restoration projects and/or have offered important lessons. A handful of such projects are discussed in the next sections, that differ in location, drivers of degradation, and the approach they took. However, some similarities are that they adopted a holistic approach to restoration targeting both human well-being and ecosystem functioning; tailored interventions to drivers of degradation; and engaged the community and other stakeholders. While the MENA region has many unique factors that need to be considered, these success stories still offer lessons and innovative ideas, and can be applicable to the region with some alterations.

RESTORATION SUCCESS STORIES OUTSIDE MENA

THE U.S. DUST BOWL

The Dust Bowl was a period of severe dust storms in the United States that had immense economic, ecologic, and human costs. In the 1930s, a serious drought, combined with excessively intensive farming practices, transformed the U.S. Great Plains into a dust bowl, wreaking economic devastation on farmers and their communities.[160, 161] With insufficient understanding of the ecology of the plains, farmers had conducted extensive deep plowing of the virgin topsoil of the Great Plains, along with using mechanized farming techniques during the previous decade, which had displaced the grasses that normally trapped soil and moisture. The Dust Bowl affected about 100 million acres in Texas and Oklahoma and forced tens of thousands of poor families to abandon their farms, with losses reaching about 25 million USD per day.[162]

[160]McLeman et al., "What We Learned from the Dust Bowl: Lessons in Science, Policy, and Adaptation."
[161]Cook, Miller, and Seager, "Did Dust Storms Make the Dust Bowl Drought Worse."
[162]"Bust: America—The Story of Us."

The greatly expanded participation of government in land management and soil conservation was an important outcome from the disaster. Many different groups were formed in response to the disaster. The Soil Conservation Service was established which generated soil maps, the United States Forestry Service launched a Prairie States Forestry Project, and the Resettlement Administration helped with the displacement of farmers.[163] Many large-scale interventions were also launched. In 1937, the federal government began an aggressive campaign to encourage farmers in the Dust Bowl to adopt planting and plowing methods that conserved the soil. The government paid reluctant farmers a dollar an acre to practice the new methods. A huge belt of more than 200 million trees from Canada to Texas was planted to improve soil quality. Education programs for farmers on soil conservation and anti-erosion techniques, including crop rotation, strip farming, contour plowing, terracing, and other improved farming practices were introduced. In addition, the government also took efforts to feed people who no longer had food to eat, and to buy back and slaughter animals that farmers couldn't afford to keep. They also created laws that helped to control market prices to stop motivating farmers from plowing over land that they shouldn't. By 1938, the massive conservation effort had reduced the amount of blowing soil by 65 percent.[164]

The restoration efforts after the Dust Bowl offer several general and specific lessons that should be applied in similar contexts. The huge economic and ecological consequences of the Dust Bowl events inspired large-scale conservation efforts that restored soil and agricultural lands to a large extent in a matter of years. Besides pushing for conservation of those lands, the government also launched education programs, introduced policies, and focused on the livelihoods of farmers which were all important to restore the land and economy. There are a few other specific lessons learned from this event and its restoration efforts. The focus was not only to plant trees but also grasses, forbs, and shrubs. Grasses prevent erosion, and their seeds feed rodents, like prairie dogs. Forbs and shrubs provide pollination benefits and are habitats for birds. Another crucial aspect was the long-term monitoring after the planting efforts to determine the effectiveness of different seed mixes and restoration techniques. Lastly, livestock was kept off seeded rangeland for at least three years as it improves the restoration effort's likelihood of success.

KOREA'S NATIONAL REFORESTATION PROGRAMME

Forest degradation in Korea had political, economic, and social drivers. Forest degradation in the Republic of Korea began before the 18th century and accelerated during World War II. The densely populated southern region experienced more extensive forest degradation, especially after the South-North division. However, the most damage was done during the Korean war between 1950 to 1953, as about half of the forest land was destroyed. The war resulted in serious economic hardship, and development policies were centered around rebuilding infrastructure and industries. Deforestation and degradation were not prioritized, and rising poverty in rural areas further exacerbated forested areas due to practices such as illegal logging, slash and burn agriculture, and fuelwood collection. Korea also experienced a population boom in the 1950s, which increased charcoal and timber demand, causing the forests to degrade further.

Korea successfully implemented the National Reforestation Programme over 25 years and restored the forest ecosystem. The programme started over 25 years ago and has had two major phases, or 'plans'. The first phase took place when the

[163]McLeman et al., "What We Learned from the Dust Bowl: Lessons in Science, Policy, and Adaptation."
[164]Hansen and Libecap, "Small Farms, Externalities, and the Dust Bowl of the 1930s."

Forest Rehabilitation Plan was still a part of the pan-government Economic Development Plans (1962–1971). The second period took place when the Korea Forest Service (KFS) led the establishment and facilitation of the Forest Rehabilitation Plans (1973 to 1987). This second phase can be divided into two 10-year Forest Rehabilitation Plans. The first national forest plan, which was launched in 1973 comprised of restoration of 1 million hectares using 2.1 billion trees in 10 years, tending care of 3.8 million ha, and erosion control work on 84,000 ha. The second phase had a planting plan for 320,000 hectares in 10 years and focused on the establishment of the large-sized commercial forest, and promotion of income sources for mountain villages, public health, environmental functions of the forest, and preservation of biodiversity.

The success of Korea's Forest Rehabilitation Programme offers important lessons. First, the most important factors were the continuous support from the head of the country, and the fact that forest rehabilitation was made the government's top priority. The president of Korea himself led the planning, implementation, and coordination of the programme. Second, it is important for the government to diagnose the underlying causes of deforestation, and then to establish a comprehensive plan to address these issues. The Korean government identified direct drivers early on, such as household fuelwood use, illegal logging, and slash-and-burn fields, and understood that the underlying cause for all these drivers was poverty. Hence, the forest rehabilitation focused equally on tree planting and livelihood development as well. Third, with clear policy objectives in the background, continuous promotion is needed to bring out the capacity of the citizens. The government announced its quantitative reforestation goal of 1 million ha within the First Plan, along with its long-term vision of complete reforestation. Due to awareness raising, the nation acknowledged the necessity and supported the government's decision. It requires strong and committed leadership along with efforts to put forest issues in the mainstream for a developing country with low-income levels to solve forest problems.

THE THREE-NORTH SHELTERBELT PROJECT (THE GREAT GREEN WALL)

To combat the loss of its grassland to the Gobi Desert, the Chinese Government started the Three-North Shelterbelt Project, also known as the Great Green Wall in 1978. Encompassing an area of 1.3 million square kilometers, the Gobi Desert is the fifth largest desert in the world and is rapidly desertifying parts of China. The expanding Gobi and the Taklamakan Desert in the northwest of China are major contributors of sandstorms in China. Deforestation, overgrazing, and overuse of water are some of the leading drivers of the expanding desert. Therefore, the central government of China proposed several programs to ameliorate local ecological conditions, and in 1978 introduced one of the biggest afforestation programs in the world called the 'Three-North Shelterbelt Project'. Since 1978, over 66 billion trees have been planted with methods such as aerial seeding and cash incentives to farmers who plant trees, shrubs, and other greenery. By 2050, the project aims to build a green wall of 35 million hectares, which would increase the forest cover of China from 5 to 14 percent.

Despite being one of the largest efforts to reverse desertification, the project has criticisms that should be considered. The project is the largest afforestation project in the world and is a popular example of efforts to reverse desertification. China has seen an increase in vegetation and a decrease in sandstorms. The project has however faced some criticism. One challenge is the issue of sustainability and suitability. There is little information about what the mortality rate of the planted trees is, with some research showing that only 15 percent of the trees planted are still standing. Additionally, grass and shrubs are more

drought tolerant and more effective at erosion control but are not prioritized in the planting plan. The rushed and immense planting plan has also meant that people have planted trees in arid regions, which has caused a decrease in soil moisture and the groundwater table.[165] The worry is that the fragile land cannot support such massive, forced growth. Others worry that China is not doing enough on the social level. To succeed, many believe the government should encourage farmers financially to reduce livestock numbers or relocate away from arid areas.[166]

THE SHINYANGA REVOLUTION

The Shinyanga revolution is a community-based restoration success story that has been cited as a model project for climate change adaptation and mitigation. The Shinyanga region, was a deserted region in Tanzania in the 1980s, as it received inadequate rainfall and experienced severe loss of vegetation. When tracing the drivers of degradation of that region, they found that there was massive tree cutting as people were told it would eliminate the tse-tse fly that infected cattle; trees were also cleared for village settlements; commercial farms expanded; and climate change started to impact the area. These drivers led to drought, degradation, and a shortage of timber and food. In 1986, the government introduced the Shinyanga Soil Conservation Initiative (HASHI) which relied on the local practice of 'Ngitili', an enclosure system where farmers conserve trees in grazing lands which then provide livestock feed and wood for energy and construction. By 2005 there were about 378,000 ha under Ngitili along with other agroforestry practices.

There are numerous enabling factors that contributed to the success of this project. First, the project clearly identifies and understands the drivers of degradation specific to the area, and solutions were targeted to those drivers. Second, local and national ownership is a prerequisite for projects, but the Tanzanian example shows that even with the dedication of government and citizens, without external donor money the restoration would not have happened at that scale. The Norwegian government supported the project for over 15 years and after their funding ran out, the Reducing Emissions from Deforestation and Forest Degradation (REDD+) came in, which enabled smallholders to reinvest in the land too. Lastly, priority must be given to the role of local people, institutions, and practices. The communities were empowered because they were involved in implementing solutions.

LOESS PLATEAU WATERSHED REHABILITATION PROJECT

The Loess Plateau, which contributed to large sand and dust storms in China, needed urgent attention. The Loess Plateau stretches over parts of seven Chinese provinces; Qinghai, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, and Henan. It gets its name from the powdery loess soil that is its primary feature. Soil erosion in the Loess Plateau contributed to massive sandstorms during the 1980s and 1990s, including the infamous 'Black Wind' of 1993.[167] Soil erosion was so severe that the plateau contributed more than 90 percent of the total sediment entering the Yellow River.[168] Furthermore, a large amount of once cultivated land had to be abandoned in the Loess Plateau due to soil degradation, resulting in economic losses of approximately 1.28 billion USD over recent decades and an unprecedented threat to food security.[169] The Loess Plateau Watershed Rehabilitation Project was initiated a year later by the World Bank as a response to these extreme events.

[165]The Epoch Times, "China's Great Green Wall Proves Hollow."
[166]Wired, "The Green Wall of China."
[167]Qian, Quan, and Shi, "Variations of the Dust Storm in China and Its Climatic Control."
[168]Chen et al., "Soil and Water Conservation on the Loess Plateau in China: Review and Perspective."
[169]Ibid.

The project attempted to break the cycle of poverty and environmental degradation by supporting sustainable agricultural practices and wealth creation. The project had two main components: (1) Land Development and Erosion Control Works; and (2) Institutional Development. The first component was further divided into the following subcomponents: (a) Terracing, (b) Afforestation, (c) Orchards, (d) Grasslands, (e) Sediment Control Dams, (f) Warping Land, (g) Irrigation; and (h) Gully control; while the second component was divided into (a) Training, (b) Research, and (c) Technology Transfer. The project resulted in restoring 4 million ha of land, more than doubling the incomes of local farmers, reducing erosion by 100 million tons of sediment annually, reducing flood risk, and dramatically increasing grain production. Socially, it aimed to strengthen household stability and reduce migration to cities. Environmentally, restoration aimed to improve soil health, reduce erosion, ensure cleaner water, and sequester carbon.[170]

Several factors were integral in rehabilitating the Loess Plateau. The World Bank estimates that the projects lifted more than 2.5 million people out of poverty, increased grain production from 365 kg to 591 kg per year, and increased employment by 17 percent.[171] The Chinese government became motivated to pursue restoration of the Loess Plateau due to several factors. As with many examples of large-scale restoration, including cases in South Korea and Ethiopia, crisis was the principal trigger to resolve to restore the Loess Plateau, with sandstorms in the late twentieth century hitting downwind urban areas. Ecological-, policy-, and market-related enabling conditions were in place to facilitate restoration in the Loess Plateau. First, via the Grain for Green program, grazing in areas designated for restoration was prohibited, resulting in a 99 percent increase in vegetation cover in those areas.[172] Second, clearing restrictions and land rights played important roles. After 1999, for instance, the government banned the cutting of trees and crop-growing on slopes, and withdrew permission for unrestricted grazing in the region. Finally, local farmers wanted help with livestock enterprises which the project incorporated. As a result, cooperation among local farmers increased and they increased planting in difficult areas for biomass harvest.

TIGRAY'S CONSERVATION-BASED AGRICULTURAL DEVELOPMENT-LED INDUSTRIALIZATION

The Tigray region in Ethiopia was suffering from degraded agricultural lands, which became a priority after the famine in 1985 and the decentralization of the government. Tigray is a state in northern Ethiopia that faced severe land degradation in the form of soil erosion, deforestation, declining biodiversity, and soil moisture stress. Expansion of farming on marginal lands and unsustainable agricultural techniques resulted in soil fertility being depleted and agricultural yield declining. The 1985 famine resulted in the establishment of the Federal Democratic Republic of Ethiopia in 1991 a country-wide process of decentralization. In 1994, Tigray adopted the Conservation-based Agricultural Development-Led Industrialization (ADLI) strategy to respond to the region's food security and agricultural yield challenge. The strategy focuses on the conservation of natural resources and emphasizes people's participation in the process.

[170]Lü et al., "A Policy-Driven Large Scale Ecological Restoration: Quantifying Ecosystem Services Changes in the Loess Plateau of China."
[171]See the World Bank project summary: http://www.worldbank.org/en/news/feature/2007/03/15/restoring-chinas-loess-plateau
[172]Cao et al., "Greening China Naturally."

The strategy adopted by Tigray prioritized sustainable agricultural practices, enhanced by capacity building, local participation, and enabling tenure rights for the landless young. Tigray's ADLI aims to attain food self-sufficiency and economic growth by encouraging agricultural technologies, expanding small-scale irrigation, developing livestock resources, conservation of natural resources, and changing land policies. Specific policy measures of Tigray's ADLI include: agricultural extension, training and research, agricultural export promotion, food security program, safety net program, and a voluntary resettlement program. Extension workers were deployed to every small rural administrative unit in Ethiopia facilities which helped in sustainably transferring skills to smallholder farmers and encouraged the uptake of sustainable agricultural practices. Two components of ADLI have contributed to its success. First was Tigray's Mass Mobilization Campaigns, a collective action initiative where communities were organized into groups and were accountable for building public and productive assets by contributing 20 labor days a year. The second was the Youth Responsive Land Policy, where landless young people were given legal landholding certificates and extension support in exchange for restoring degraded lands.

Massive improvements have been made in previously degraded landscapes through Tigray's ADLI strategy with a major factor being its participatory approach. People of Tigray are restoring land on a massive scale and the policy was recently recognized with the Future Policy Gold Award 2017, awarded by the World Future Council in partnership with the UNCCD. Erosion has decreased significantly, mainly due to changes in crop cover and conservation practices. Studies that have evaluated the success of the strategy have also pointed out that the key success factor was the mass mobilization campaign.[173] The Youth Responsive Land Policy also helped established 740 youth groups with more than 15,000 members (of which 40 percent are women) which enabled tenure rights to over 2850 hectares. The approach provides an integrated landscape management model for restoration of drylands. The effective mobilization of local farmers was a key success factor and is a cost-effective way to enhance welfare and sustainable land management.

RESTORATION OF THE BRAZILIAN ATLANTIC RAIN FOREST

Centuries of deforestation and degradation of the Atlantic Forest in Brazil led to the formation of the Atlantic Forest Restoration Pact in 2009. The Atlantic Forests, which extend along the Atlantic coast of Brazil, have experienced a reduction in forest cover of over 80 percent from the last 500 years. Forest clearing for coffee plantations and cattle ranching, and logging for hardwoods are the principle threats to the forest.[174] Weak environmental governance, poor compliance, and concern for the Atlantic Forest pressured governments to enforce laws more rigorously and prioritize the restoration of the forest.[175] Restoration efforts in the early 2000s were disorganized, with poor dialogue between stakeholders, and limited incentives for implementation. Taking these challenges into consideration, the Atlantic Forest Restoration Pact was established in 2009. The pact is a multi-stakeholder coalition aiming to restore 1 million hectares of the Atlantic Forest by 2020.[176]

The pact is a multi-stakeholder effort with sound monitoring systems and technical guides for the restoration of the Atlantic Forest. The aim of the pact is to promote biodiversity conservation and livelihood development; restore key ecosystem

[173]Haregeweyn et al., "Integrated Watershed Management as an Effective Approach to Curb Land Degradation: A Case Study of the Enabered Watershed in Northern Ethiopia."
[174]Pinto et al., "Governing and Delivering a Biome-Wide Restoration Initiative: The Case of Atlantic Forest Restoration Pact in Brazil."
[175]Rodrigues et al., "On the Restoration of High Diversity Forests: 30 Years of Experience in the Brazilian Atlantic Forest."
[176]Aguilar et al., "Toward a Post-conflict Colombia: Restoring to the Future."

services; and provide incentives for landowners to comply with the Forest Act. The pact is a joint effort of more than 270 members from various private and public institutions and organizations. The pact has a rigorous monitoring tool in place and technical maps, models, and guides for restoration efforts. To reduce the negative impacts of climate change on society and their livelihoods, the pact is involving society in the protection and restoration of nature to improve peoples' standard of living.

SUSTAINABLE LAND MANAGEMENT PROJECT IN ETHIOPIA

The Sustainable Land Management Project, implemented by the World Bank, transformed degraded watersheds in Ethiopia to healthy productive lands. The objective of the Sustainable Land Management Project was to reduce land degradation and improve land productivity in selected watersheds in targeted regions in Ethiopia. There were four components to the project, the first component being integrated watershed and landscape management. The objective of this component was to support scaling up and adoption of appropriate sustainable land and water management technologies and practices by smallholder farmers and communities in the selected watersheds. The second component was the institutional strengthening, capacity development and knowledge generation, and management. The third component was the rural land administration. The objective of this component was to enhance the tenure security of smallholder farmers in the project area in order to increase their motivation to adopt sustainable land and water management practices on communal and individual land. In 10 years, 10 million ha were improved through enclosure, 15 million ha were treated with conservation measures, and 13 million people benefited.

High-level commitments, community engagement, and employing a landscape approach were the main reasons of success of the project. There were three key aspects that were crucial for the success of the project. First, commitments at the highest level, where addressing degradation, was made a top priority and ensured that the government and civil society were united in their approach. The second aspect was that it was demand driven. Planning started with communities in their own watersheds, with support from experts, so the community decided and implemented solutions of their choice. Thirdly, a landscape approach was used, where landscapes were divided into rainfed, irrigated, grazing, and highlands, and interventions planned accordingly.

IN SUMMARY

Successful projects have a range of investors, and in most cases, significant contributions from the country's government. Four out of the seven initiatives discussed have mainly been funded by the country's federal government. While government funding is usually limited, in these cases the severity of the problem and the benefits from restoration were significant enough for massive government funding. Some of the projects obtained financing from multiple sources, such as the government, international donors, and the private sector. This is a good strategy for very large projects as it makes them less dependent on one funding source. Some projects are funded by foreign companies, such as the Brazil Atlantic Forest Restoration which is funded by Ecosia, a German social company that raises funds from a search engine.

Factors such as clear motivation, enabling conditions, and resources for sustained implementation were vital for the success of the projects. The projects highlighted demonstrate a variety of approaches to land degradation on a small and large scale. Three common themes for successful restoration were identified: (i) A clear motivation:

decision makers, landowners and/or citizens were motivated to restore land; (ii) Enabling conditions in place: enough ecological, market, policy, social and/or institutional conditions were in place to create a favorable context for restoration; and (iii) capacity and resources for sustained implementation: capacity and resources existed and were mobilized to implement restoration on a sustained basis on the ground. Table 13 provides a list of such success factors for each of these themes from a Restoration Diagnostic. In addition, Table 14 provides a summary of the projects discussed in the previous section and the unique lessons learned or key success factors for each of them. These factors are crucial to consider when designing restoration projects in MENA.

TABLE 13: KEY SUCCESS FACTORS FOR RESTORATION

Theme	Feature	Key Success Factor
Motivate	Benefits	» Restoration generates economic benefits
		» Restoration generates social benefits
		» Restoration generates environmental benefits
	Awareness	» Benefits of restoration are publicly communicated
		» Opportunities for restoration are identified
	Crisis events	» Crisis events are leveraged
	Legal requirements	» Law requiring restoration exists
		» Law requiring restoration is broadly understood and enforced
Enable	Ecological conditions	» Soil, water, climate, and fire conditions are suitable for restoration
		» Plants and animals that can impede restoration are absent
		» Native seeds, seedlings, or source populations are readily available
	Market conditions	» Competing demands (e.g., food, fuel) for degraded forestlands are declining
		» Value chains for products from restored area exists
	Policy conditions	» Land and natural resource tenure are secure
		» Policies affecting restoration are aligned and streamlined
		» Restrictions on clearing remaining natural forests exist
		» Forest clearing restrictions are enforced
	Social conditions	» Local people are empowered to make decisions about restoration
		» Local people are able to benefit from restoration
	Institutional conditions	» Roles and responsibilities for restoration are clearly defined
		» Effective institutional coordination is in place
Implement	Leadership	» National and/or local restoration champions exist
		» Sustained political commitment exists
	Knowledge	» Restoration "know-how" relevant to candidate landscapes exists
		» Restoration "know-how" transferred via peers or extension services
	Technical design	» Restoration design is technically grounded and climate resilient
		» Restoration limits "leakage"
	Finance and incentives	» Positive incentives and funds for restoration outweigh negative incentives
		» Incentives and funds are readily accessible
	Feedback	» Effective performance monitoring and evaluation system is in place
		» Early wins are communicated

Source: Buckingham and Hanson, 2015.[177]

[177]Buckingham and Hanson, "The Restoration Diagnostic."

TABLE 14: LESSONS LEARNED FROM RESTORATION PROJECTS

Initiative Name	Region	Year Started	Donors	Lessons
US dust bowl[178]	United States of America	1933	Federal government	a) Education programs for farmers. b) Livelihood development prioritized. c) Planted grass and shrubs as well as trees, as grass and shrubs are more effective in reducing erosion. d) Long-term monitoring and evaluation. e) Livestock kept off seeded rangeland.
National Reforestation Program[179]	Korea	1962	Federal government	a) Rehabilitation was made top priority by the government. b) Identified poverty as a major driver and addressed that. c) Awareness raising for the public about the importance of restoration. d) Strong financial support from the government helped implement the National Reforestation Programme.
Great Green Wall/ Three-North Shelterbelt[180]	China	1978	Federal government; international donors; some financing by the private sector	a) Largest afforestation project in the world. b) Should not only plant trees in arid regions. Climate suitability should be considered. c) Afforestation should be supplemented with livelihood development for farmers and foresters.
Shinyanga restoration[181]	Tanzania	1986	Norwegian government (15 years); smallholder investments	a) Drivers of degradation identified, and solutions targeted those drivers. b) Continuous international donor support. c) Communities consulted and involved in implementation.

(continues)

[178]https://en.m.wikipedia.org/wiki/Dust_Bowl
[179]https://www.cbd.int/ecorestoration/doc/Korean-Study_Final-Version-20150106.pdf
[180]https://news.nationalgeographic.com/2017/04/china-great-green-wall-gobi-tengger-desertification/; http://theplaidzebra.com/china-is-building-a-great-green-wall-of-trees-to-stop-desertification/
[181]http://blog.worldagroforestry.org/index.php/2016/09/28/shinyanga-revolution-tanzanian-success-story-creates-momentum-land-restoration/

TABLE 14: CONTINUED

Initiative Name	Region	Year Started	Donors	Lessons
Loess Plateau Watershed Rehabilitation Project[182]	China	1994	World Bank; federal government	a) Grazing in restoration areas was prohibited. b) Strict rules on tree cutting and unrestricted grazing. c) Helped farmers with livestock enterprises.
Tigray's Conservation-Based Agricultural Development-Led Industrialization[183]	Ethiopia	1994	Implementation of these policies was supported by: FAO-Managing Environmental Resources to Enable Transition (MERET) project, the multi-donor funded Productive Safety Net Programme, and the Sustainable Land Management Programme	a) Mass mobilization program encouraged local ownership of restoration efforts. b) Youth responsive land policy enabled tenure rights for the landless young.
Restoration of the Brazilian Atlantic Rain Forest[184]	Brazil	2009	Ecosia—German company	a) Involves multiple stakeholders, such as NGOs, research institutions, and government agencies. b) Rigorous monitoring system in place. c) Maps, models, and guides made available for restoration efforts.

UNIQUE FACTORS OF THE MENA REGION

The MENA region mostly consists of drylands, so interventions must consider drought conditions. As demonstrated in Chapter 1, the MENA region is mainly characterized by arid or semiarid lands. As about 60 percent of MENA's land is considered hyper-arid, less than 40 percent of the total land is used for grazing and agriculture, most of which is in arid and semiarid conditions (Table 5). According to the Intergovernmental Panel on Climate Change (IPCC) it is expected that precipitation will decrease, and temperature will increase, as well as the magnitude and frequency of drought that will consequently increase over the MENA region over the coming decades. Therefore, interventions for restoring degraded land in MENA must be suitable for the dry climate in the region. Additionally, while the MENA region does have some forested land, most of the arable land is used for agriculture and livestock. Grazing land and cropland interventions are therefore more relevant for MENA than forested land.

[182]http://projects.worldbank.org/P003540/loess-plateau-watershed-rehabilitation-project?lang=en
[183]https://www.futurepolicy.org/healthy-ecosystems/tigrays-conservation-based-adli/
[184]http://www.bonnchallenge.org/content/brazils-atlantic-forest-restoration-pact

Compared to other regions in the world, many countries in MENA are suffering from fragility, conflict, and violence that should be factored in when designing restoration projects. Due to rich resources, mainly oil and gas, combined with its location between three continents, (Asia, Africa, and Europe), the MENA region has been in constant conflict. Some pertinent conflicts are the Israeli–Palestinian conflict; the Iran–Iraq War; Iran–Saudi Arabia proxy conflict; and the rise of terrorism impacting Libya, Syria, and Yemen. Regional cooperation would be challenging and must be done tactfully. Furthermore, restoration interventions must be conflict resilient. Therefore, restoration must aim to not escalate any conflict, be considerate of violent pockets, and ensure that interventions are sustained despite ongoing conflict.

In addition to unfavorable climate and conflict, MENA also has a relatively large amount of degraded land. While there are no estimates that specifically compare the MENA region to other large regions in the world in terms of land degradation, it is still worthwhile to observe degradation levels in Africa and Asia compared to other continents. The two continents have much more degraded land, ranging from 10,000 to 250,000 hectares, which is about 10 times as much as other continents, depending on the study and methodology used. Most of the land that is degraded suffers from irreversible degradation, with some parts less degraded that could be restored. Additionally, some of the land is also vulnerable to desertification. Hence, different types of financing scales and sources should be pursued depending on the extent and severity of degradation.

The main drivers of degradation should be addressed when designing interventions to manage land in MENA. Many interrelated factors contribute to desertification, including population growth, demands for greater levels of production, technologies that increase resource exploitation, and climate change. In MENA, there are some factors that are particularly prominent. MENA has experienced a very rapid population increase in recent years, which has led to increased urbanization, land clearing, and agricultural expansion. Unsustainable farming practices are being used causing groundwater depletion and soil salinity. Furthermore, most of the productive land in MENA is rangeland, and increased food demand has led to overgrazing, which has caused rangeland degradation. Another important driver of land degradation is weak land tenure and ineffective governance over natural resources, particularly in communally managed areas like grasslands and dry forests. Lastly, climate change and unsustainable farming practices are also contributing toward extreme events such as sand and dust storms, which are both a cause and effect of land degradation. Restoration interventions should therefore address these challenges and drivers (Box 10).

BOX 10: SUMMARY OF FACTORS AND DRIVERS OF LAND DEGRADATION RELEVANT TO MENA

Factors that are relevant to the MENA region:

a) Dryland

b) Violent conflict

c) Severe degradation

Drivers of land degradation:

a) Urbanization, land clearing, and agricultural land expansion

b) Overgrazing

c) Inefficient water management and groundwater depletion

d) Soil salinity

e) Climate change and extreme events such as sand and dust storms

f) Weak land tenure and land governance

RECOMMENDATIONS

A MENA regional land restoration program should build on previous success, integrate the unique factors of MENA, the drivers of desertification, and bring in impact investors to finance at scale. The recommendations are divided into technical and instrumental, where technical recommendations are further grouped into water management-based strategies, forest restoration, rangeland strategies, and sustainable agriculture interventions. Table 15 provides a comprehensive list of these strategies; however, only those that are relevant and prioritized for the MENA region are discussed in this section. Instrumental approaches include better government coordination and capacity, more research, improving land rights and livelihoods for land-dependent people, and promoting indigenous local knowledge and practices. Technical interventions should be complemented with instrumental responses, and a set of interventions should be designed according to the context of the specific country. Finally, there needs to be a dramatic scale-up of restoration efforts that slow, and eventually reverse, the onset of land degradation. To do that, new financing mechanisms need to be designed to incentivize greater private sector participation in land restoration outcomes.

TABLE 15: MANAGEMENT STRATEGIES ACCORDING TO RESPONSE CATEGORIES

Response Category	Management Strategies and Policy Options
Direct biophysical and technical responses	
Cropland degradation	Conservation agriculture; integrated crop, livestock, and forestry systems; enhanced plant genetics; agroforestry; agroecology
Forest land degradation	Protected areas; restrictions on forest conversion; promotion of sustainable forest management practices; fire management; passive and active restoration

Response Category	Management Strategies and Policy Options
Direct biophysical and technical responses	
Rangeland degradation	Land capability and condition assessment and monitoring; grazing pressure management; pasture and forage crop improvement; silvo-pastoral management; weed and pest management
Soil management	Improved agronomic practices; reduced tillage; increased diversity and vegetative cover in production systems; integrated crop, livestock, and forestry systems; improved fertilizer and agrochemical use efficiency; improved irrigation and water use efficiency; reduced deposition of atmospheric pollutants
Enabling and instrumental responses	
Legal and regulatory instruments	Land-use planning (national, regional, local); social and environmental impact assessments; incentives for sustainable land-use practices; establishment of protected areas
Rights-based instruments and customary norms	Improved land tenure security; clarification of natural resource-use rights; support for Indigenous and Local Knowledge and Practices (ILK) based traditional use practices
Economic and financial instruments	Policy-induced price changes; payments for ecosystem services; biodiversity offsets; improved land tenure security; clarification of natural resource-use rights; natural capital accounting
Social and cultural instruments	Participatory natural resource management and governance; support for ILK-based traditional use practices; eco-certification; promotion of corporate social responsibility
Protected areas	Legal protection; private and community-based conservation; promotion of ILK-based traditional use
Climate change adaptation planning	Conservation of natural areas with high carbon stores (e.g., peatlands, old-growth forests, mangroves); land-use specific measures to reduce net greenhouse gas emissions; land-use specific adaptation measures
Integrated landscape planning	Sustainable land management; integrated planning and management; zoning
Anthropogenic assets	Capacity-building including: skills and knowledge development; research and technological development; extension; human resource development; infrastructure and facilities
Institutional and policy reform	Establishment of new institutions; strengthening existing institutions; mainstreaming Indigenous and ILK practices; improving multilevel governance mechanisms

Source: IPBES, 2018.

TECHNICAL

Sustainable cropping

Integrated crop, livestock, and forests are a proven approach to sustainable land management in the drylands. Trees on farms provide shade for humans, crops and edible fruits and nuts, and livestock; deliver nutrients and help stabilize soils; and provide emergency animal feed and other raw materials. Many countries, such as Brazil, Indonesia, China, and India, have started to employ agroforestry practices. Some 43 percent of agricultural

land globally has at least a 10 percent tree cover.[185] In Niger, agroforestry has undergone somewhat of a renaissance with over 5 million hectares restored through the revival of simple practices of selective protection of high-value trees within farming landscapes.[186] Farmers are using a variety of techniques to encourage regeneration or the planting of native tree species, including the Zaï technique, which encourages tree planting in small holes filled with manure, usually in combination with stone bunds as part of the Farmer-Managed Natural Regeneration (FMNR) approach.[187] According to a recent World Bank study, when FNMR is added to other productivity enhancing interventions, the proportion of drought-affected people in 10 countries in East and West Africa would fall by about 13 to 50 percent.[188] Another strategy for restoring degraded agricultural land is to incorporate perennials and cattle into traditional row-crop production systems, also known as sustainable intensification. Integrated crop and livestock systems have been used to restore degraded croplands in North America, Western Europe, Brazil, Uruguay, and Argentina.[189] For instance, integrated crop and livestock systems have increased the amount of cultivated pasture in Brazil to nearly 101 million hectares as compared to 57 million hectares of native pasture.

Adoption of conservation agriculture can be an effective preventive and mitigating strategy for addressing cropland degradation. Conservation agriculture as defined by the FAO is characterized by three actions: (i) continuous minimum mechanical soil disturbance; (ii) permanent organic soil cover; and (iii) diversification of crop species grown in sequences and/or associations. Conservation agriculture is applicable to all agricultural landscapes as it emphasizes the use of local knowledge and native biological processes.[190] Many countries have adopted conservation agriculture, as about 125 million hectares (9 percent of arable cropland) is now managed using conservation agriculture.[191] No or low-till agriculture is a form of conservation agriculture which can also restore degraded lands in drylands. No- or low-till agriculture minimizes soil disturbance and maintains crop residues and other organic matter on the soil surface where it helps to reduce evaporative losses and increase infiltration. No-till agriculture requires substantial changes in farming practices; but it is still more profitable than conventional farming as it reduces the cost of labor, fuel, irrigation, and machinery. Dryland countries such as Australia, Argentina, and the U.S. are using no-till agriculture to a large extent, where in the U.S. it accounts for 22.6 percent of all cropland areas.[192]

Rangeland management

The use of local customs and technology for rangeland planning can be very effective in restoring rangeland degradation. The most widespread land use in drylands is extensive livestock production or pastoralism. Pastoralists use both natural and artificial infrastructure for their water supply, including deep wells, tanks, and surface ponds. Degradation occurs in these water supply areas where people are encouraged to permanently settle with their livestock. Pastoralists often have elaborate customs and arrangements governing the use of water and pasture, enabling equitable communal resource use over

[185]Zomer et al., "Global Tree Cover and Biomass Carbon on Agricultural Land."
[186]Pye-Smith, The Quiet Revolution.
[187]Bado, Savadogo, and Manzo, "Restoration of Degraded Lands in West Africa Sahel."
[188]Carfagna, Cervigni, and Fallavier, Mitigating Drought Impacts in Drylands.
[189]Franzluebbers, Sawchik, and Taboada, "Agronomic and Environmental Impacts of Pasture–Crop Rotations in Temperate North and South America."
[190]Forest Peoples Programme, "Customary Sustainable Use of Biodiversity by Indigenous Peoples and Local Communities: Examples, Challenges, Community Initiatives and Recommendations Relating to CBD Article 10(c)."
[191]FAO, "Conservation Agriculture Adoption Worldwide."
[192]Shaxson et al., "Underpinning Conservation Agriculture's Benefits: The Roots of Soil Health and Function."

vast areas and in some cases across international boundaries.[193] Poorly planned water infrastructure projects can undermine these traditional systems.[194] Developing and implementing grazing management plans are effective responses to avoid and reduce rangeland degradation at sensitive parts such as slopes, water points, and riparian strips. Key considerations include the land condition (such as rainfall and soil fertility); community structure (local knowledge and tenure rights for example); and grazing level and distribution. Countries are now taking measures to strengthen local regulation of resource use by linking customary tenure with state institutions and involving tools like remote sensing and telecommunications to enable more efficient rangeland planning.

Livestock and crop composition can be changed or managed according to the geographical and climatic conditions. Rangeland management can be improved by the selection of well-adapted species chosen for their genetic potential (e.g., drought resistance) and ability to utilize a range of ecological niches. Additionally, herds can be disaggregated to avoid overgrazing and loaning animals to others to build or rebuild herds as a form of social capital.[195] In Namibia, some farms have replaced domestic livestock altogether with the management and cull of wild antelope and zebra, which are better adapted to arid conditions.[196] Similarly, more suitable crops can substitute existing ones if they can prevent overgrazing. Degraded rangelands can be restored by planting productive plant species that are nutritious and palatable to livestock. Spineless cactus (Opuntia ficus-indica), saltbushes (Atriplex), and wattles (Acacia) have been successfully introduced in Algeria and Tunisia; the higher water content of cactus appeals to sheep, and aids in their digestion.

Better water management

Small-scale irrigation and the use of freshwater substitutes such as brackish and wastewater have a lot of potential to reduce agricultural water scarcity in MENA. Irrigation development in general is imperative in dryland agriculture. A recent World Bank study found that irrigation development will benefit up to 1.7 million people in 10 countries in Africa, where most people who benefit would be from semiarid regions.[197] Small-scale irrigation is being more widely used as it can be more carefully controlled to supplement rainfall at critical times in the growing cycle by boosting growth or extending the growing season.[198] Additionally, Brackish (slightly salty) water is widely available in MENA, and its use for irrigation can take pressure off the scarce supplies of fresh water. Brackish water can also be used to irrigate salt-tolerant landscaping plants in the expanding urban areas and highways of MENA. Another opportunity is wastewater reuse for irrigation. With appropriate treatment, wastewater can provide both irrigation and fertilizer to more than 2 million hectares. In Israel, the use of drip irrigation systems combined with recycling wastewater has led to a 1,600 percent increase in the value of produce grown by local farmers over the last 65 years.[199] However, health concerns should be addressed, and wastewater irrigation would only be suitable for certain crops.

[193]Admas and Anderson, "Irrigation before Development: Indigenous and Induced Change in Agricultural Water Management in East Africa."
[194]Gomes, "Access to Water, Pastoral Resource Management and Pastoralists' Livelihoods."
[195]Hesse, Pastoralism.
[196]Barnes and Jones, "Game Ranching in Namibia. Evolution and Innovation in Wildlife Conservation."
[197]Carfagna, Cervigni, and Fallavier, Mitigating Drought Impacts in Drylands.
[198]Adams and Carter, "Small-Scale Irrigation in Sub-Saharan Africa."
[199]Tal, "Rethinking the Sustainability of Israel's Irrigation Practices in the Drylands."

Appropriate irrigation and cropping techniques must be employed to avoid salinization, which is a prevalent problem in MENA's agricultural lands. Salinization negatively affects soil health and quality by impairing productivity and several ecosystem functions. Globally, 23 percent of all irrigated land is classified as saline.[200] Response strategies to prevent soil salinization such as: (i) preventing excessive groundwater withdrawal and seawater intrusion, (ii) irrigating only where there is proper drainage, (iii) increasing aquifer recharge, and (iv) improving land and water management decisions, have been developed in response to an estimated $27.3 billion in lost crop production, alone.[201] Other more specific measures to avoid soil salinity include: using high quality (low electrical conductivity) irrigation water; applying sufficient irrigation water to leach soluble salts below the plant root zone; planting of salt tolerant cultivars; implementing phytoremediation with halophytes and subsequently harvesting them; adding calcium sulfate or strong acids; and increasing organic matter.[202]

Besides irrigation, crops and cropping systems can also be engineered to become more water-efficient. While improving irrigation systems is important, appropriate crops and cropping practices can also be sustainable in the drylands of MENA. For instance, salt-tolerant species for brackish-water irrigation, and drought-tolerant crops should be planted. Growing salt-tolerant crops often have an added soil health and/or quality benefit, because they generally support the formation of stable soil aggregates that improve infiltration and resistance to wind erosion, while also decreasing surface crusting. Plant breeding may also be able to modestly increase the salt and drought tolerance of some species used for human consumption in MENA, particularly cereal crops like barley and wheat. Besides crops, technologies are available and being developed that can improve water use efficiency. For example, the estimation of crop water requirements based on climatic conditions measured by automated weather stations can help farmers know when and how much irrigation will give the optimum payoff.

Forest restoration

Forest restoration and reforestation not only restores degraded forested land, but also restores degraded croplands and rangelands, and works effectively against sand and dust storms, which are a significant threat in the MENA region. Afforestation of unused, marginal, and abandoned land, as well as harvesting forests more frequently, could further promote carbon sequestration.[203, 204, 205, 206] A variety of effective reforestation and forest management techniques are used to varying extents such as protection of natural regrowth; restoration plantings; and tree plantation of native species or non-invasive exotic species. According to the World Resources Institute, more than 1.5 billion hectares can be restored worldwide by employing integrated systems such as agroforestry. Examples provided previously of the China Loess Plateau, The U.S. dust bowl, Korea's reforestation program, and Brazil's Atlantic Forest restoration are all successful examples of large-scale forest restoration that have had many positive impacts. Government and community buy-in is important for restoration to work, as for example in Korea's example, their approach included a combination of economic and policy coordination as well as rural livelihood development to decrease poverty.

[200]IUSS Working Group, "World Reference Base for Soil Resources."
[201]Qadir et al., "Economics of Salt-induced Land Degradation and Restoration," 2014.
[202]FAO, "Status of the World's Soil Resources (SWSR)–Main Report," 2015.
[203]Bird and Boysen, The Carbon Sequestration Potential from Afforestation in Ontario.
[204]Harris et al., "Ecological Restoration and Global Climate Change."
[205]Liu and Hiller, "A Continuing Inquiry into Ecosystem Restoration."
[206]Valatin and Price, "How Cost-Effective Is Forestry for Climate Change Mitigation?"

ENABLING APPROACHES

Economic and political instruments that incentivize sustainable land management practices are important tools against land degradation. Land-use practices often result in externalities, as the costs of unsustainable land management practices are disproportionately borne by off-site parties who don't receive compensation. Economic and financial instruments internalize such externalities through two types of incentive mechanisms: restrictive and supportive. Restrictive incentives are for negative externalities such as emission taxes, and supportive incentives are for positive externalities such as subsidies and payments for ecosystem services. Privatization of farms has also proved to be an effective economic incentive that can increase incomes as well as restore land (Box 11). IPBES's assessment report on land degradation and restoration has additional details on a variety of such economic and financial instruments with evidence from various countries.[207]

Supportive political environment and institutional capacity play an important role in the success of projects aimed at combating desertification. Stakeholders in land management need to work together more effectively at local and regional levels. So, collaboration between the government, research institutions, NGOs, private sector, and community organizations should be enabled. Improved coordination between sectors, such as agriculture, wildlife, forestry, and water is also needed for a holistic approach to land management. Furthermore, in the MENA region particularly, institutional capacity needs to be built to address desertification. The institutional capacity of countries to handle environmental issues varies across the region, but overall, technical expertise and authority need to be strengthened. Oman and Tunisia have made progress in strengthening their capacity in environmental policy making. Algeria, Egypt, Morocco, and Saudi Arabia are restructuring their environmental institutions. Risk assessment has been introduced in Algeria, Egypt, and

BOX 11: LAND RESTORATION IN ISRAEL THROUGH PRIVATIZATION AND ECONOMIC INCENTIVES

The Northern Negev in Israel, which has relatively good soil quality, has been exploited for rainfed field crops, grazing, and agroforestry for thousands of years. Overexploitation followed by neglect has left the farmlands degraded. Traditional land use and ownership were disrupted during the creation of the state of Israel, with land transformed to public rangeland, intensive agriculture, or forestry, leaving a large area under disputed ownership.[208, 209]

Private farms for rainfed extensive agriculture were created to improve management of open rangelands. Selected farmers were given 100 ha farms (50-year leases), along with detailed management proposals. This privatization coupled with scientific advice allowed cost-effective land restoration. Planting of olive orchards, other fruit trees, medical plants, and silvopasture trees enhanced watershed protection, soil and biodiversity conservation, and economic potential. These measures reduced erosion, increased carbon sequestration, and increased farm income from olive oil and other agroforestry products.[210] The well-documented recovery from a limited number of low-cost restoration measures make widespread application of such initiatives a promising option for large-scale restoration of agroecological landscapes.

Source: UNCCD, 2017.

[207]Montanarella, L., Scholes, R., and Brainich, A., "The IPBES Assessment Report on Land Degradation and Restoration."
[208]Leu, Mussery, and Budovsky, "The Effects of Long Time Conservation of Heavily Grazed Shrubland."
[209]Helman et al., "Detecting Changes in Biomass Productivity in a Different Land Management Regimes in Drylands Using Satellite-Derived Vegetation Index."
[210]Mor-Mussery, Leu, and Budovsky, "Modeling the Optimal Grazing Regime of Acacia Victoriae Silvopasture in the Northern Negev, Israel."

Tunisia to identify priorities. Several countries, including members of the Gulf Cooperation Council, have made environmental impact assessment mandatory for new development projects.

An Integrated Landscape Management (ILM) approach should be employed, which offers a collaborative multi-sectoral method to landscape restoration. ILM is way of managing a landscape that involves collaboration among multiple stakeholders. For instance, forest degradation cannot be addressed without addressing food security, and agricultural production cannot be separated from soil erosion and land degradation—calling for harmonized interventions. There are five key features of Integrated Landscape Management: (i) Multi-stakeholder platforms; (ii) Shared vision; (iii) Collaborative planning; (iv) Synergistic technical practices; and (v) Enabling policies. Multi-stakeholder platforms at the landscape level help shareholders share information and develop common understanding and trust. Stakeholders from different fields and perspective, can agree on multiple objectives and come up with shared vision which could be a sustainable resilient landscape. Collaborative planning is a way for stakeholders to plan how they will meet their objectives and shared vision, and come up with solutions with multiple benefits. Local stakeholders then identify the desirable practices, such as agroforestry or conservation agriculture, and policy and financing options to scale them up. Finally, the fifth feature relates to markets and enabling policies to scale up landscape level actions

When designing responses to land degradation drivers or processes, local knowledge and customary practices should be given high priorities. Many indigenous people have lived for thousands of years on their land without causing desertification, and they could offer many solutions to the problem. Any policy taken to combat desertification should take into account the ways of life of indigenous peoples in the areas affected and try to incorporate their knowledge into an overall action plan. Community or indigenous knowledge-based approaches have been proven effective in restoring degraded land and conserving soils and water in many parts of the world (Box 12).[211] A key element of success for both the Shinyanga restoration project in Tanzania and Tigray's restoration project in Ethiopia was consulting communities and using mass mobilization campaigns. It is important to recognize that customary practices adopted by local people have significance in halting land degradation. Understanding the enabling sociocultural factors—which could be defined on the basis of a rights-based approach, customary practices, and/or participatory processes—are instrumental to the success of land degradation or restoration responses.[212]

Interventions should also address P.R.I.M.E. pathways out of poverty so that poverty is addressed along with land degradation. Empirical evidences from many developing countries suggest that halting land degradation is possible and often effective when customary practices of local people and their rights to fulfill basic needs are incorporated in resource governance mechanisms.[213, 214] While it is often not feasible for a single project to address all five PRIME constraints, implementers should still evaluate their restoration projects against the PRIME framework. Productivity enhancing interventions are usually the norm, however equally important is to secure land rights, strengthen complementary

[211]Agarwal, "Gender and Forest Conservation: The Impact of Women's Participation in Community Forest Governance."
[212]Reed, M. S., & Stringer, L., "Climate Change and Desertification: Anticipating, Assessing & Adapting to Future Change in Drylands-Impulse Report. In 3rd UNCCD. Scientific Conference. Cancun, Mexico: Agropolis International and Groupe CCEE."
[213]Agarwal, "Gender and Forest Conservation: The Impact of Women's Participation in Community Forest Governance."
[214]Forest People Program & Program, "Customary Sustainable Use of Biodiversity by Indigenous Peoples and Local Communities: Examples, Challenges, Community Initiatives and Recommendations Relating to CBD Article 10(c)."

BOX 12: USE OF INDIGENOUS KNOWLEDGE TO IMPROVE SOIL HEALTH IN INDIA

Indigenous and local knowledge (ILK) has influenced many traditional soil and water conservation practices in India, such as terracing, applying soil amendments, water harvesting, controlling seepage, recharging groundwater, optimizing tillage, and using different land configurations. One prominent example in India is the use of mixed and diversified cropping systems to improve soil health. In rainfed areas, farmers use traditional practices to grow various crops (such as millet) that exploit different growth habits and rooting patterns. These differences enable the crops to use nutrients and soil water from different soil layers which increases resource-use efficiencies. This builds more canopy closure which prevents weed growth, competition with annual crops, and monsoon-induced erosion. In addition, the sequence of crops is selected such that it enables the above-ground crops to be harvested before the underground crops and supports grazing of crop residues by animals. The combination of residual root biomass, crop residue, animal excreta, and farmyard manure helps sustain the soil organic matter content, which in turn improves soil health, crop nutritional status, and economic returns to farmers.

Source: Mishra, 2002.[215]

BOX 13: A PES SCHEME IN ECUADOR

PES schemes can be an important way to support farmers and land managers that provide ecosystem services.[216] Some prominent examples are protecting forests to maintain water quality or reducing stocking levels in hilly country to encourage vegetation growth to reduce flooding. A PES scheme in Quito, Ecuador, on watershed protection is a good example. About 80 percent of Quito's 1.5 million population receive drinking water from two protected areas: Antisana (120,000 ha) and Cayambe-Coca Ecological Reserve (403,103 ha). The government of Ecuador is collaborating with NGOs and farming communities to protect the watersheds, including protecting upper watersheds, improve hydrological functions and waterholes, prevent erosion, and stabilize banks and slopes.[217] The PES schemes for farmers focus on carbon sequestration, forest conservation, watershed protection and disaster risk reduction, where payments can also be made in kind such as in the form of equipment or beehives.[218]

Source: UNCCD, 2017.

institutions, enable market access, and increase the benefits from ecosystem services through mechanisms such as Payments for Ecosystem Services (PES) (Box 13).

More research is needed on degradation in MENA and how and why land users degrade their land. As demonstrated in the first chapter, degradation is hard to define, and measure and data are scarce, especially for the MENA region. While many studies have attempted to show the extent and cost of degradation, the methodology used differs and so it is hard to know the extent of desertification conclusively. The lack of funding for dryland development coincides with a lack of support for dryland research; our understanding of the rates and causes of desertification remain woefully incomplete. Additionally, research is also needed on the drivers and limiting factors that lead to land degradation. This research

[215]Mishra, "Indigenous Technical Knowledge (ITKS) for Efficient Soil and Water Management."
[216]Pagiola, Landell-Mills, and Bishop, "Market-Based Mechanisms for Forest Conservation and Development."
[217]Troya and Curtis, "Water."
[218]Wunder, "Payments for Environmental Services."

should also focus on land tenure systems, which constitute a major impediment to communities living in fragile ecosystems. Desertification is complicated by a range of definitions and a variety of causes and symptoms; different degrees of expression that are difficult to measure; and a shortage of practical tools and techniques for measuring how desertification is affected by different remedial practices. Without good information it is difficult to issue early warnings of impending drought and damage to lands.

FINANCIAL

Appropriate funding sources and funding instruments must be identified to finance restoration. First and foremost, it is important to be aware of the landscape of potential funders and donors that exist on all levels. Any restoration action that requires investment will be successful only if the necessary funding is mobilized and made accessible. Different financing opportunities exist to provide support to different entities, according to their financial outreach, agenda of priorities, and geographical coverage.[219] Multilateral donors, bilateral donors, development banks, philanthropic foundations and the private sector (e.g., core business, corporate social responsibility projects, commercial loans, etc.) are examples of institutions where financial support can be available. Some donors use nongovernmental organizations (NGOs) to channel their funds, while others have country offices and can finance projects directly.

Appendix B elaborates on some of the most relevant financing opportunities, consisting of international institutions, public and private sector, for implementing restoration projects and programs. In addition, for money to flow, a financial instrument or mechanism is required to channel funding from investors to investees. Private sector financial instruments include equity, loans, and bonds (including green bonds). Fiscal instruments include grants, subsidies, taxes, and other incentives.

Private-sector investors are the key to long-term restoration finance, whether as social investors in the framework of corporate social responsibility or as impact investors looking for a mix of social and financial returns. Numerous case studies show successful private sector investment—in terms of Corporate Social Responsibility (CSR), traditional investing, or impact investing—on all continents and these success stories should be shared and replicated. CSR-related corporate engagement for restoration offers abundant potential, with several possible strategies, including philanthropy, sponsoring, and impact marketing. The private sector should also be involved in restoration finance, considering many of the drivers of land degradation are linked to private sector activities, such as unsustainable timber harvest and agriculture. For instance, Timber Investment Management Organizations (TIMOs) are traditional investors that have been involved in financing large-scale restoration for years. Private equity impact funds should also be pursued as they attract different kinds of investors, including institutional investors, cooperation agencies, high net-worth individuals, pension funds and private foundations, among others. More than ten private equity impact funds (already operational or in design) seek to invest in landscape restoration projects. Table 16 lists some private equity impact funds that target the MENA region. Lastly, a variety of innovative approaches involving the private sector—such as zero net deforestation initiatives, ecological compensation, payments for ecosystem services and restoration bonds—also have huge potential in reducing the restoration funding in MENA.

[219]UNCCD, "Land Degradation Neutrality TRANSFORMATIVE ACTION, Tapping Opportunities."

TABLE 16: PRIVATE EQUITY IMPACT FUNDS INVOLVED WITH RESTORATION

Fund	Contributions to Restoration	Geographical Scope	Source of Capital
Althelia Climate Funds	Large-scale mosaic projects combining conservation and restoration (about USD 10 million per project)	Africa, Asia, Latin America	Private and public sector institutions such as the Church of Sweden, European Investment Bank, Finnfund, FMO
Terra Bella Fund	Community-based forest and agricultural emission reduction projects (about USD 5−10 million per project)	Africa, Latin America, and Southeast Asia	Private and public sector institutions
Permian Global	Protection and recovery of natural forests	Africa, Latin America, and Southeast Asia	Private and public sector institutions
Livelihoods Carbon Fund	Mangrove restoration, agroforestry, and rural energy	Africa, Latin America, and Southeast Asia	Private companies (e.g., Danone, SAP software, Michelin), developmental agencies, NGOs
Livelihoods Fund for Family Farming (Livelihoods 3F)	Large-scale sustainable agriculture projects (EUR 120 million [~USD 137 million] invested)	Africa, Latin America, and Southeast Asia	Private companies (Danone, Mars), development agencies, NGOs
Landscape Fund (under design)	Large portfolio of small-scale projects led by smallholders	Developing and developed countries	Private companies, public institutions, restoration bonds
Land Degradation Neutrality Fund	Large-scale land rehabilitation; activities include sustainable agriculture, sustainable forest management, renewable energy, ecotourism	Developing and developed countries, worldwide	Institutional investors, pension funds, private foundations, protected by DFI funding

Source: FAO and UNCCD, 2015.[220]

Restoration faces a huge financing gap due to systematic, public and private finance barriers, but there are some strategies that can facilitate financial flows. To accelerate the pace of restoration, practitioners should consider a range of strategies. First, carbon taxes should be imposed, where some of its revenue could fund restoration. Not only would this promote low-carbon development but also provide funding for restoration. Another similar strategy is to leverage climate finance for restoration. Restoration should be acknowledged as a part of climate mitigation and adaptation strategy. Third, governments should also reform their current incentive systems (such as agricultural

[220]FAO and Global Mechanism of the UNCCD, "Sustainable Financing for Forest and Landscape Restoration: Opportunities, Challenges and the Way Forward."

subsidies) which currently make it profitable to degrade land. As restoration generates benefits for multiple areas of the economy, governments should also adopt an integrated approach that crosses various ministries and government bodies, to increase their capacity for restoration. Lastly, projects can also be bundled as it decreases risks, increases investment size, and increases liquidity which is more attractive to private investors (Box 14). A summary of these strategies is presented in Figure 21.

BOX 14: AGGREGATING PROJECTS TO ATTRACT CAPITAL: THE EXPERIENCE OF FORESTFINANCE GROUP

Since 1995, the ForestFinance Group has been investing retail investors' savings in the restoration of degraded forest landscapes in Colombia, Panama, Peru, and Vietnam. On its own, any one of the restoration projects would be too small to attract funding. By aggregating them under one umbrella, ForestFinance was able to raise capital.

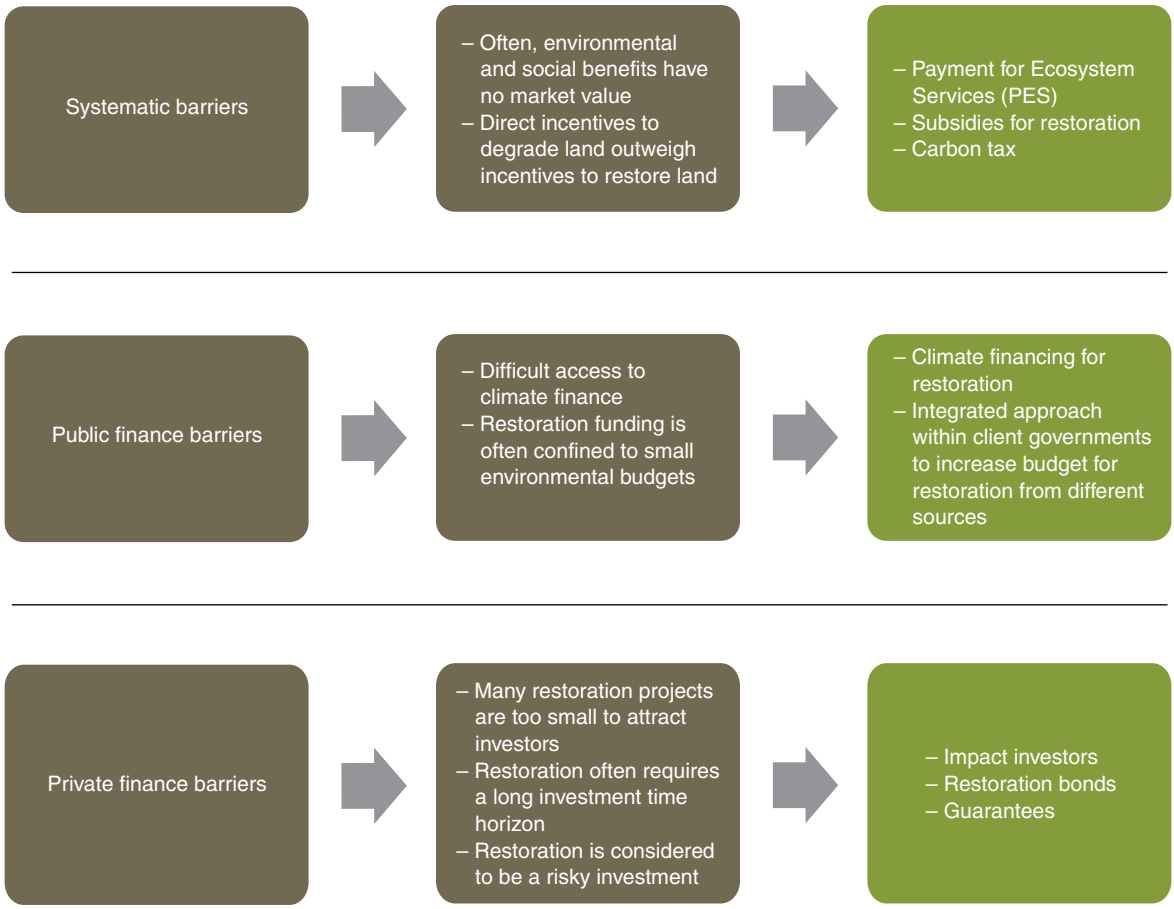
The company offers various investment products in developed countries. It manages forest investments of about $100 million for more than 18,000 clients, using the funds to reforest degraded pasturelands and grow mixed-species forests. After 25 years, ForestFinance harvests some of the trees and sells the timber. As of 2016, ForestFinance had 17,500 hectares of forests under management, of which it has restored more than 7,500.

Contract Terms (years)	Investment	Area Restored	Returned Forecast	Payouts	Restoration Concept
25	12 monthly payments of 38 Euros or one payment of 396 Euros	From 0.0125 hectares	6 percent	About 1,745 Euros after 25 years	Mixed forest
25	One payment of 3,250 Euros	From 0.1 hectares	6 percent	Annually from year 6; totaling about 7,735 Euros	Cacao cultivation and rain forest protection
12	One payment of 2,656 Euros	From 0.25 hectares	6 percent	On years 3, 5, 7, 9, and 12; totaling about 4,990 Euros	Mixed forest

Source: ForestFinance Group, 2017; WRI, 2017.[221, 222]

[221]ForestFinance Group, "Forest Products."
[222]World Resources Institute, "Roots of Prosperity. The Economics and Finance of Restoring Land."

FIGURE 21: FINANCING BARRIERS AND SOLUTIONS



Source: WRI, 2017.

APPENDIX A: WORLD BANK LAND MANAGEMENT PROJECTS IN MENA

TABLE 17: WORLD BANK SUSTAINABLE LAND MANAGEMENT PROJECTS IN MENA

Title	Country	Timeframe	Description
Environmental Management Support Project	Iran	2003–2009	Component 1: Strengthening institutional capacity to monitor air and water; Component 2: Building partnership through pilot environmental projects; Component 3: Training and public awareness programs to improve air and water quality
Irrigation Based Community Development	Morocco	2001–2009	Component 1: Improvement of SMI schemes serving an area of approximately 9,450 ha; Component 2: Improvement of complementary community infrastructure not covered by ongoing sectoral programs; Component 3: Institutional support for (a) participatory, integrated investment programming through a training and technical assistance program, and (b) agricultural development activities to intensify production practices.
Agricultural Support Services Project	Tunisia	2001–2009	Component 1: Building the capacity of agricultural producers and interprofessional organizations; Component 2: Strengthening the supply of research, training, and farming advisory services; Component 3: Livestock and animal health; Component 4: Plant protection and seed and plant certification.
Northwest Mountainous and Forestry Areas Development Project	Tunisia	2003–2010	Component 2: Implementation of pilot operations; Component 3: Agricultural and livestock development; Component 4: Sustainable natural resource management; Component 5: Improvement of basic rural infrastructure.
Rainfed Agriculture Development Project	Morocco	2003–2012	Component 1: Strengthening of implementation capacity for rainfed agricultural development; Component 2: Developing new instruments and institutional capacity to improve support services for rainfed agriculture, notably: (a) drought management and (b) agricultural research.

Title	Country	Timeframe	Description
Integrated Ecosystem Management in the Jordan Rift Valley GEF	Jordan	2007–2014	Component 1: Assessment and strategic planning for integrated ecosystem management in the Jordan Rift Valley; Component 2: Development of a network of biodiversity conservation sites, embodying the principles of integrated ecosystem management; Component 3: Integrated assessments of climate change impacts on biodiversity conservation in the JRV developed to support conservation planning and implementation; Component 4: Sustainable financing mechanisms for protected areas (PAs) strengthened.
Rainfed Agriculture and Livestock Project	Yemen, Republic of	2007–2015	Component 1: Farmer-based system of seed improvement and management: (a) promoting within the project area ex-situ and on-farm conservation of local land races by enhancing capacity, and (b) carrying out a program for promoting seed producer groups in the project area; Component 3: Productive rural development: (a) enhancing the organizational capacity of poor rural producers at the community and intercommunity levels, (b) provision of poor rural producer (PRP) grants to poor rural producer groups, and (c) establishing a flow of market information between local producers and distant market stakeholders.
Agro-Biodiversity and Adaptation	Yemen, Republic of	2010–2015	Component 1: Agro-biodiversity and local knowledge utilization and assessment; Component 3: Integrating climate change into rainfed agriculture: (a) awareness generation, and (b) piloting coping strategies (network strengthening, planning, capacity for accessing grants for microenterprises, coping strategies—infrastructure, and coping strategies—income generation/diversification).
JO-Badia Ecosystem and Livelihoods	Jordan	2013–2017	Component 1: Community-centered ecotourism in the Northern Badia: (a) establishment of an Al Azraq/Shaumari-Burqu' ecotourism corridor, and (b) fostering community engagement in the planning, development, and operation of the ecotourism corridor; Component 2: Adaptive rangeland management & alternative livelihoods support in the Southern Badia: (a) construction of long-lasting multipurpose water harvesting structures (hafirs), (b) establishment and/or rehabilitation of improved rangeland reserves, and (c) maintaining and enhancing livelihoods in target communities.

(continues)

TABLE 17: CONTINUED

Title	Country	Timeframe	Description
4th Northwest Mountainous and Forested Areas Development Project (PNO4)	Tunisia	2011–2017	Component 1: Support for agricultural and pastoral production and income-generating activities in the project area: (a) technical training to farmers, (b) the dissemination of genetic material, and (c) the establishment or rehabilitation of small-scale irrigation schemes; Component 2: Consolidation, protection, and management of natural resources in the project area: (a) expand and improve the vegetation cover in targeted project areas, (b) improve the status of selected forested areas through participatory forest management, and (c) promote more sustainable natural resource management techniques and practices; Component 3: Improvement of basic rural infrastructure in the project area.
Tunisia Second Natural Resources Management Project	Tunisia	2010–2018	Component 1: Support to participatory development plan investments: (a) improving water access and water management, (b) constructing and rehabilitating rural feeder roads, (c) developing sustainable agricultural production systems, (d) exploiting non-wood forestry products, (e) applying water and land conservation techniques, (f) mainstreaming organic and climate resilient farming, (g) providing related training on sustainable land management practices, and (h) promoting activities aimed at preventing further land degradation caused by intensified farming and ecosystem encroachment.
Morocco Social and Integrated Agriculture	Morocco	2013–2019	Component 1: Development of the capacities of public and private institutions on land and biodiversity conservation; Component 2: Transfer of land and biodiversity conservation measures among small farmers.
TN-Oases Ecosystems and Livelihoods Project	Tunisia	2014–2020	Component 1: Strengthening capacities for sustainable management of oasis ecosystems; Component 2: Supporting the implementation of the PDPOs: (a) community micro-projects in the area of sustainable management of land and water (SLWM) and biodiversity, and (b) community micro-projects in the area of the diversification of local livelihoods.
Smallholder Agricultural Production Restoration and Enhancement Project	Yemen, Republic of	2018–2021	Component 1: Community subprojects and investments: (a) strengthening community land and water management, (b) improving animal husbandry, livestock production, and animal health services, and (c) improving livelihood and nutrition, and increasing value-added of selected agriculture products; Component 2: Capacity building and extension: (a) capacity building activities to strengthen skills of stakeholders involved in service provision in the project areas, and (b) extension activities for project beneficiaries in a range of fields.

Title	Country	Timeframe	Description
Integrated Landscapes Management in Lagging Regions Project	Tunisia	2017–2024	Component 1: Laying the foundations for sustainable management of agricultural resources: (a) improving agricultural, forest, and rangeland data, (b) adopting integrated landscape development planning, (c) strengthening the technical and managerial capacities of various stakeholders, and (d) strengthening relevant institutional and legal frameworks. Component 2: Fostering sustainable regional investments: (a) climate-smart and sustainable agriculture (e.g., soil fertility management techniques), (b) complementary local infrastructure (e.g., feeder roads), and (c) the development of agricultural products.

TABLE 18: OTHER EXAMPLES OF SUCCESSFUL RESTORATION PROJECTS

Initiative Name	Region	Year Started	Implementers
Conservation tillage in prairie[223]	Canada	1970	Local producers
Mexico—Mixteca Region (Oaxaca)—Fighting Desertification with Community Reforestation and Sustainable Agriculture[224]	Mexico	1980	Center for Integral Farmer Development (CEDICAM)
The Zabré women's agroecological project, Burkina Faso[225]	Burkina Faso	1987	Zabre association
Community Forest User Group[226]	Nepal	1993	Federal government
Sustainable—Hunshandake Sandland management of marginal drylands (SUMAMAD)[227]	China	2000	Multiple NGOs, government
Ethiopia's Productive Safety Net Program—PSNP[228]	Ethiopia	2005	Federal government, World Food Programme (WFP)
Mainstreaming Sustainable Land Management—SLM—in Agropastoral Production Systems in Kenya[229]	Kenya	2010	GEF

[223]https://www.sciencedirect.com/science/article/pii/S2095633915300137
[224]http://www.ecotippingpoints.org/our-stories/indepth/mexico-oaxaca-community-reforestation-mixteca-region.html
[225]https://qa.wocat.net/SummaryApproach1.php?selected_id=47&selected...english
[226]http://fecofun.org.np/
[227]http://fust.iode.org/sumamad
[228]https://www.wfp.org/content/protective-safety-net-programme-ethiopia
[229]http://documents.worldbank.org/curated/en/821721522701042604/pdf/ICR-Main-Document-P091979-2018-03-27-13-23-03282018.pdf

APPENDIX B: FINANCING OPPORTUNITIES FOR LAND DEGRADATION

Funder/Donor	Description	How to Access
Global Environment Facility (GEF)	The GEF's main focus is grant funding through four modalities: full-sized projects (over 2 million USD); medium sized projects (up to 2 million USD); enabling activities (under 1 million USD) and programmatic approaches. Non-grant instruments are also available for specific initiatives.	Projects can be developed and submitted through 18 GEF agencies including UNEP, UNDP, World Bank, Regional Development Banks, WWF, IUCN, and Conservation International. Funding proposals are largely "mainstreamed" in the project preparation cycle of these organizations.
Global Climate Fund (GCF)	Low-emission (mitigation) and climate resilient (adaptation) projects and programs developed by the public and private sectors: Risk-based approach depending on funding size for micro (up to 10 million USD), small (10–50 million USD), medium (50–250 million USD), and large (over 250 million USD) size projects and programs. GCF provides grants with and without repayment contingency, as well as loans and equity.	Directly through accredited subnational, national, or regional implementing Accredited Entities; and International Accredited Entities, including UN agencies, development banks, and NGOs.
Climate Investment Funds (CIF)	The 8.3 billion USD Climate Investment Funds (CIF) is providing 72 developing and middle-income countries with urgently needed resources to manage the challenges of climate change and reduce their Greenhouse Gas emissions. Total CIF pledges are expected to attract an additional 58 billion USD of co-financing for a portfolio of over 300 projects and programs and counting.	CIF is implemented through five multilateral development banks: World Bank, African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, and the Inter-American Development Bank.
Adaptation Fund	The Adaptation Fund has piloted direct and regional access and provides grants of up to 10 million USD for concrete adaptation projects in nine thematic focus areas. The projects need to result in outputs that are visible and tangible, which always entails a concrete on-the-ground investment: i.e., pure capacity building or research projects are not eligible.	Through national, multilateral and regional implementing entities including UN agencies, development banks, NGOs, or directly through national implementing entities. Proposals are accepted three times a year for review at annual board meetings and in-between sessions, either as a full proposal or as a concept note.

Funder/Donor	Description	How to Access
Land Degradation Neutrality (LDN) Fund	The LDN Fund is focused on direct investment into larger-scale land restoration, rehabilitation, and land degradation avoidance programs that will integrate smallholders and local communities and has a dedicated window for small-scale projects and small- and medium-sized enterprises.	The Fund will only consider projects that can make a significant contribution to LDN while producing appropriate risk adjusted returns and complying with robust environmental and social standards. Projects should have already successfully completed a pilot/feasibility project and be looking for further investment to support a scale up.
International Development Association (IDA)	The International Development Association (IDA) is part of the World Bank Group and it is the fund for the world's 75 poorest countries. Since its establishment in 1960, IDA has provided 312 billion USD in loans and grants. Annual commitments have averaged about 19 billion USD per year. In its 18th replenishment cycle, IDA has been able to mobilize approximately 75 billion USD for the IDA18 period from 2017 to 2020.	IDA resources are made available to IDA eligible countries based on several criteria and approved according to the objectives set in the Country Partnership Framework of the World Bank Group.
Multilateral Development Banks (MDBs)	The MDBs provide technical and financial support in the form of credits, concessional loans, and grants, as well as technical assistance for low- and middle-income countries. Resources are allocated for a range of sectors, such as agriculture, environmental and natural resource management, and climate action. Thus, the MDBs play an important role in financing LDN.	The MDBs have dedicated private sector branches that facilitate private sector investments and public private partnerships, for example, for agriculture or forestry investments. Among these outlets are the World Bank's International Finance Cooperation (IFC) or IDB's Inter-American Investment Cooperation (IIC) that have mobilized financing from the private sector to support sustainable forest management, conservation agriculture, and other projects. In the fiscal year 2016, IFC invested 3.4 billion USD in agribusiness.
International Development Finance Club (IDFC)	In 2014 the members of the IDFC had collective commitments of 630 billion USD. Often parts of the bilateral development finance are channeled through these banks, such as KFW for Germany or AFD for France.	Several IDFC members focus on the private sector or have established dedicated private sector branches. In addition to grants, concessional loans and credits, development banks can often leverage additional public and private funds through debt, equity shares, or de-risking investments. De-risking investments, for example, use public guarantees or insurances to overcome risks
Private impact investors	Over the past decade 31 private funds and project promoters—also called private impact investors—invested around 7 billion USD in projects contributing to LDN. They expect to double their financing by 2021.	Many private sector initiatives are already supporting the ambitious LDN target, including those, which have subscribed to the Bonn Challenge to restore 150 million hectares of degraded and deforested lands by 2020. While the private sector role in LDN is increasing, many of its engagements still require public support to be accelerated.

Source: Adapted from UNCCD, 2017.[230]

[230]UNCCD "Land Degradation Neutrality TRANSFORMATIVE ACTION, Tapping Opportunities."

REFERENCES

Adams, William M., and R. C. Carter. "Small-Scale Irrigation in Sub-Saharan Africa." *Progress in Physical Geography* 11, no. 1 (1987): 1–27.

Admas, William M., and David M. Anderson. "Irrigation before Development: Indigenous and Induced Change in Agricultural Water Management in East Africa." *African Affairs* 87, no. 349 (1988): 519–35.

Agarwal, Bina. "Gender and Forest Conservation: The Impact of Women's Participation in Community Forest Governance." *Ecological Economics* 68, no. 11 (2009): 2785–99.

Aguilar, Mauricio, Jorge Sierra, Wilson Ramirez, Orlando Vargas, Zoraida Calle, William Vargas, Carolina Murcia, James Aronson, and José I. Barrera Cataño. "Toward a Post-conflict Colombia: Restoring to the Future." *Restoration Ecology* 23, no. 1 (2015): 4–6.

Ahmed Hussein, Muawya. "Costs of Environmental Degradation: An Analysis in the Middle East and North Africa Region." *Management of Environmental Quality: An International Journal* 19, no. 3 (2008): 305–17.

Alix-Garcia, Jennifer, and Hendrik Wolff. "Payment for Ecosystem Services from Forests." *Annu. Rev. Resour. Econ.* 6, no. 1 (2014): 361–80.

Allen, C. D., A. K. Macalady, H. Chenchouni, D. Bachelet, N. McDowell, and M. Vennetier. 2010. A Global Overview of Drought and Heat-Induced Tree Mortality Reveals Emerging Climate Change Risks for Forests. Forest Ecology Management. 259, 660–684. Doi: 10.1016/j.foreco. 2009.09. 001."

Altieri, Miguel A. "Agroecology: The Science of Natural Resource Management for Poor Farmers in Marginal Environments." *Agriculture, Ecosystems & Environment* 93, no. 1–3 (2002): 1–24.

AOAD. "Arab Agricultural Statistics Yearbook." Arab Organization for Agricultural Development, Khartoum, 2014.

AOAD. "First Meeting for National Focal Points of Arab Network for Rangelands Sustainable Development," Arab Organization for Agricultural Development, Khartoum, 2015.

Bado, V. B., Patrice Savadogo, and Maman Laminou Sanoussi Manzo. "Restoration of Degraded Lands in West Africa Sahel: Review of Experiences in Burkina Faso and Niger" (2016).

Bai, Z. G., D. L. Dent, L. Olsson, M. E. Schaepman. "Proxy Global Assessment of Land Degradation" *Soil Use and Management,* 24 (3) (2008): 223–234.

Barbier, Edward B. "Is Green Growth Relevant for Poor Economies?" *Resource and Energy Economics* 45 (2016): 178–91.

Barbosa, H. A., TV Lakshmi Kumar, and L. R. M. Silva. "Recent Trends in Vegetation Dynamics in the South America and Their Relationship to Rainfall." *Natural Hazards* 77, no. 2 (2015): 883–99.

Barnes, J. I., and B. Jones. "Game Ranching in Namibia. Evolution and Innovation in Wildlife Conservation." *Parks and Game Ranches to Transfrontier Conservation Areas*, 2009.

BenDor, Todd, T. William Lester, Avery Livengood, Adam Davis, and Logan Yonavjak. "Estimating the Size and Impact of the Ecological Restoration Economy." *PloS One* 10, no. 6 (2015): e0128339.

Bird, D. Neil, and Eric P. Boysen. *The Carbon Sequestration Potential from Afforestation in Ontario.* Ministry of Natural Resources, Applied Research and Development Branch (2007).

Brando, Paulo Monteiro, Jennifer K. Balch, Daniel C. Nepstad, Douglas C. Morton, Francis E. Putz, Michael T. Coe, Divino Silvério, Marcia N. Macedo, Eric A. Davidson, and Caroline C. Nóbrega. "Abrupt Increases in Amazonian Tree Mortality Due to Drought–Fire Interactions." *Proceedings of the National Academy of Sciences* 111, no. 17 (2014): 6347–6352.

Breisinger, Clemens, Teunis Van Rheenen, Claudia Ringler, Alejandro Nin Pratt, Nicolas Minot, Catherine Aragon, Bingxin Yu, Olivier Ecker, and Tingju Zhu. "Food Security and Economic Development in the Middle East and North Africa." *International Food Policy Research Institute* (2010), 1–52.

Briske, David D., Linda A. Joyce, H. Wayne Polley, Joel R. Brown, Klaus Wolter, Jack A. Morgan, Bruce A. McCarl, and Derek W. Bailey. "Climate-change Adaptation on Rangelands: Linking Regional Exposure with Diverse Adaptive Capacity." *Frontiers in Ecology and the Environment* 13, no. 5 (2015): 249–56.

Buchner, B., C. Trabacchi, F. Mazza, D. Abramskiehn, and D. Wang. *Global Landscape of Climate Finance 2015: A Climate Policy Initiative Report* (2015).

Buckingham, K., and C. Hanson. "The Restoration Diagnostic: Case Example: Shinyanga Region, Tanzania." World Resources Institute: Washington, DC (2015).

Bulte, Erwin H., Leslie Lipper, Randy Stringer, and David Zilberman. "Payments for Ecosystem Services and Poverty Reduction: Concepts, Issues, and Empirical Perspectives." *Environment and Development Economics* 13, no. 3 (2008): 245–54.

"Bust: America—The Story of Us." A&E Television Networks, 2010.

Cai, X., X. Zhang, and D. Wang. "Land Availability for Biofuel Production." *Environmental Science & Technology,* 45: 334–339, 2011.

Calhoun, Aram J. K., David M. Mushet, Kathleen P. Bell, Dani Boix, James A. Fitzsimons, and Francis Isselin-Nondedeu. "Temporary Wetlands: Challenges and Solutions to Conserving a 'Disappearing' Ecosystem." *Biological Conservation* 211 (2017): 3–11.

Campbell, J. E., D. B. Lobell, R. C. Genova, C. B. Field. "The Global Potential of Bioenergy on Abandoned Agriculture Lands." *Environmental Science and Technology,* 42 (15) (2008): 5791–5794.

Cao, Shixiong, Ge Sun, Zhiqiang Zhang, Liding Chen, Qi Feng, Bojie Fu, Steve McNulty, David Shankman, Jianwu Tang, and Yanhui Wang. "Greening China Naturally." *Ambio* 40, no. 7 (2011): 828–31.

Carfagna, Federica, Raffaello Cervigni, and Pierre Fallavier. *Mitigating Drought Impacts in Drylands: Quantifying the Potential for Strengthening Crop- and Livestock-Based Livelihoods.* The World Bank (2018).

Carter, David L. "Problems of Salinity in Agriculture." In *Plants in Saline Environments,* 25–35. Springer (1975).

CFU (Climate Funds Update). "Which Climate Funds Focus on REDD+Finance?" (2017). http://www.climatefundsupdate.org/themes/redd

Change, IPCC Climate. "Mitigation of Climate Change." *Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* 1454 (2014).

Charreau, Claude. "Problèmes Posés Par l'utilisation Agricole Des Sols Tropicaux Par Des Cultures Annuelles." *L'Agronomie Tropicale. Série 2, Agronomie Générale. Etudes Techniques* 27, no. 9 (1972): 905–29.

Chen, Liding, Wei Wei, Bojie Fu, and Yihe Lü. "Soil and Water Conservation on the Loess Plateau in China: Review and Perspective." *Progress in Physical Geography* 31, no. 4 (2007): 389–403.

Cheng, Guodong, and Tonghua Wu. "Responses of Permafrost to Climate Change and Their Environmental Significance, Qinghai—Tibet Plateau." *Journal of Geophysical Research: Earth Surface* 112, no. F2 (2007).

Cherlet, M., C. Hutchinson, J. Reynolds, J. Hill, S. Sommer, and G. von Maltitz. *World Atlas of Desertification.* Publication Office of the European Union, 2018.

Chhatre, Ashwini, and Arun Agrawal. "Trade-Offs and Synergies between Carbon Storage and Livelihood Benefits from Forest Commons." *Proceedings of the National Academy of Sciences* 106, no. 42 (2009): 17667–70.

Clarke, Michèle L., and Helen M. Rendell. "Climate, Extreme Events and Land Degradation." In *Climate and Land Degradation,* 137–52. Springer, 2007.

Colfer, C. J. P., M. Elias, and R. Jamnadass. "Women and Men in Tropical Dry Forests: A Preliminary Review." *International Forestry Review* 17, no. 2 (2015): 70–90.

Cook, Ben, Ron Miller, and Richard Seager. "Did Dust Storms Make the Dust Bowl Drought Worse." Lamont-Doherty Earth Observatory. *New York (NY): Published by The Earth Institute at Columbia University,* 2009.

Credit Suisse, WWF (World Wildlife Fund), and McKinsey and Company. "Conservation Finance: Moving Beyond Donor Funding toward an Investor-Driven Approach" (2014). https://www.cbd.int/financial/privatesector/g-private-wwf.pdf

Croitoru, Lelia, and Maria Sarraf. *The Cost of Environmental Degradation: Case Studies from the Middle East and North Africa.* The World Bank, 2010.

Davidson, Nick C. "How Much Wetland Has the World Lost? Long-Term and Recent Trends in Global Wetland Area." *Marine and Freshwater Research* 65, no. 10 (2014): 934–41.

De Janvry, Alain, and Elisabeth Sadoulet. "Agricultural Growth and Poverty Reduction: Additional Evidence." *The World Bank Research Observer* 25, no. 1 (2009): 1–20.

Denier, Louisa, S. Scherr, Seth Shames, Paul Chatterton, Lex Hovani, and Nienke Stam. "The Little Sustainable Landscapes Book: Achieving Sustainable Development through Integrated Landscape Management," 2015.

Dirzo, Rodolfo, Hillary S. Young, Mauro Galetti, Gerardo Ceballos, Nick J. B. Isaac, and Ben Collen. "Defaunation in the Anthropocene." *Science* 345, no. 6195 (2014): 401–6.

Dregne, H. E. "Erosion and Soil Productivity in Africa." *Journal of Soil and Water Conservation* 45, no. 4 (1990): 431–36.

Dregne, Harold E., and Nan-Ting Chou. "Global Desertification Dimensions and Costs." *Degradation and Restoration of Arid Lands,* 1992, 73–92.

Economy, New Climate. "The Global Commission on the Economy and Climate." *Washington DC: World Resources Institute,* 2014.

Egan, Timothy. *The Worst Hard Time: The Untold Story of Those Who Survived the Great American Dust Bowl.* Houghton Mifflin Harcourt, 2006.

El Mangouri, Hassan. "Dryland Management in the Kordofan and Darfur Provinces of Sudan." In *Dryland Management: Economic Case Studies.* Earthscan Publications, Ltd. London, 1990.

Eriksson, Janne, Ingé Haekanson, and Birger Danfors. *The Effect of Soil Compaction on Soil Structure and Crop Yields.* Swedish Institute of Agricultural Engineering, 1975.

European Committee of the Regions. "The Relationship between Desertification and Climate Change in the Mediterranean," 2011.

FAO. "Aquastat Main Database," Food & Agricultural Organization (FAO), 2000.

———. "TERRASTAT: Global Land Resources GIS Models and Databases for Poverty and Food Insecurity Mapping," 2002.

———. " Iraq Country Profile," 2011.

———. "Aquastat Main Database," 2014.

———. "Conservation Agriculture Adoption Worldwide," 2015.

———. "Aquastat Main Database," 2018.

FAO and Global Mechanism of the UNCCD. "Sustainable Financing for Forest and Landscape Restoration: Opportunities, Challenges and the Way Forward." Rome, 2015.

FAO, ITPS. "Status of the World's Soil Resources (SWSR)–Main Report." *Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils, Rome, Italy* 650 (2015).

Faour, Ghaleb. "Detection and Mapping of Long-Term Land Degradation and Desertification in Arab Region Using MODESERT." *Lebanese Science Journal* 15, no. 2 (2014): 119.

Field, Christopher B. *Climate Change 2014—Impacts, Adaptation and Vulnerability: Regional Aspects.* Cambridge University Press, 2014.

Foley, Jonathan A., Navin Ramankutty, Kate A. Brauman, Emily S. Cassidy, James S. Gerber, Matt Johnston, Nathaniel D. Mueller, Christine O'Connell, Deepak K. Ray, and Paul C. West. "Solutions for a Cultivated Planet." *Nature* 478, no. 7369 (2011): 337.

Forest Peoples Programme. "Customary Sustainable Use of Biodiversity by Indigenous Peoples and Local Communities: Examples, Challenges, Community Initiatives and Recommendations Relating to CBD Article 10(c)," 2010.

ForestFinance Group. "Forest Products" (2017). https://www.forestfinance.de/en/#c3054

Franzluebbers, Alan J., Jorge Sawchik, and Miguel A. Taboada. "Agronomic and Environmental Impacts of Pasture–Crop Rotations in Temperate North and South America." *Agriculture, Ecosystems & Environment* 190 (2014): 18–26.

Gibbs, H. K., and J. Megham Salmon. "Mapping the World's Degraded Lands." *Applied Geography* 57 (2015): 12–21.

Gill, William R. "Economic Assessment of Soil Compaction." *Compaction of Agricultural Soils* (1971).

Gilmour, Don. *Forty Years of Community-Based Forestry: A Review of Its Extent and Effectiveness.* FAO (2016).

Gomes, Nathalie. "Access to Water, Pastoral Resource Management and Pastoralists' Livelihoods." *Lessons Learned from Water Development in Selected Areas of Eastern Africa (Kenya, Ethiopia, Somalia). FAO: Livelihoods Support Programme Working Paper* 26 (2006).

Graetz, R. D. "Desertification: A Tale of Two Feedbacks" (1991).

Haberl, Helmut, K. Heinz Erb, Fridolin Krausmann, Veronika Gaube, Alberte Bondeau, Christoph Plutzar, Simone Gingrich, Wolfgang Lucht, and Marina Fischer-Kowalski. "Quantifying and Mapping the Human Appropriation of Net Primary Production in Earth's Terrestrial Ecosystems." *Proceedings of the National Academy of Sciences* 104, no. 31 (2007): 12942–47.

Hansen, Zeynep K., and Gary D. Libecap. "Small Farms, Externalities, and the Dust Bowl of the 1930s." *Journal of Political Economy* 112, no. 3 (2004): 665–94.

Haregeweyn, Nigussie, Ademnur Berhe, Atsushi Tsunekawa, Mitsuru Tsubo, and Derege Tsegaye Meshesha. "Integrated Watershed Management as an Effective Approach to Curb Land Degradation: A Case Study of the Enabered Watershed in Northern Ethiopia." *Environmental Management* 50, no. 6 (2012): 1219–33.

Harris, James A., Richard J. Hobbs, Eric Higgs, and James Aronson. "Ecological Restoration and Global Climate Change." *Restoration Ecology* 14, no. 2 (2006): 170–176.

Helman, D., A. Mussery, I. M. Lensky, and S. Leu. "Detecting Changes in Biomass Productivity in a Different Land Management Regimes in Drylands Using Satellite-Derived Vegetation Index." *Soil Use and Management* 30, no. 1 (2014): 32–39.

Hesse, Ced. Pastoralism: Drylands' Invisible Asset?: Developing a Framework for Assessing the Value of Pastoralism in East Africa. 142. IIED, 2006.

Hoover, David L., Michael C. Duniway, and Jayne Belnap. "Testing the Apparent Resistance of Three Dominant Plants to Chronic Drought on the Colorado Plateau." *Journal of Ecology* 105, no. 1 (2017): 152–62.

Huybers, Twan, and Jeff Bennett. "Impact of the Environment on Holiday Destination Choices of Prospective UK Tourists: Implications for Tropical North Queensland." *Tourism Economics* 6, no. 1 (2000): 21–46.

IFAD. "Syrian Arab Republic: Thematic Study on Participatory Rangeland Management in the Badia." International Fund for Agricultural Development, Rome, Italy (2012).

Initiative, E. L. D. "The Value of Land: Prosperous Lands and Positive Rewards through Sustainable Land Management." Available from www.Eld-Initiative.org. 2015.

IPBES. "The IPBES Assessment Report on Land Degradation and Restoration." Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany (2018).

Irz, Xavier, Lin Lin, Colin Thirtle, and Steve Wiggins. "Agricultural Productivity Growth and Poverty Alleviation." *Development Policy Review* 19, no. 4 (2001): 449–66.

IUCN. "Enhancement of Natural Capital through Forest and Landscape Restoration (FLR)," 2012.

IUSS Working Group, W. R. B. "World Reference Base for Soil Resources." *World Soil Resources Report* 103 (2006).

Jordan Ministry of Agriculture. "Updated Rangeland Strategy for Jordan." Directorate of Rangeland and Badia Development, in collaboration with the IUCN. Jordan (2014).

Jorgenson, M. Torre, Vladimir Romanovsky, Jennifer Harden, Yuri Shur, Jonathan O'Donnell, Edward AG Schuur, Mikhail Kanevskiy, and Sergei Marchenko. "Resilience and Vulnerability of Permafrost to Climate Change." *Canadian Journal of Forest Research* 40, no. 7 (2010): 1219–36.

Kayombo, B., and R. Lal. "Responses of Tropical Crops to Soil Compaction." In *Developments in Agricultural Engineering*, 11:287–316. Elsevier, 1994.

Khordagui, H. "Water Scarcity in West Asia, Ecosystem Dimensions, SDPD-UN-ESCWA," 2015.

Kraay, Aart, and David McKenzie. "Do Poverty Traps Exist? Assessing the Evidence." *Journal of Economic Perspectives* 28, no. 3 (2014): 127–48.

Lal, Rattan. "Soil Erosion Impact on Agronomic Productivity and Environment Quality." *Critical Reviews in Plant Sciences* 17, no. 4 (1998): 319–464.

———. "Carbon sequestration in dryland ecosystems of West Asia and North Africa." Land Degradation & Development 13.1 (2002): 45–59.

Larsen, Bjorn. "Cost Assessment of Environmental Degradation in the Middle East and North Africa Region: Selected Issues." In *Economic Research Forum*, Working Paper, Vol. 583, 2011.

Le, Q. B., Nkonya, E., and Mirzabaev, A. "Biomass Productivity-based Mapping of Global Land Degradation Hotspots." ZEF-Discussion Papers on Development Policy (193). ZEF, University of Bonn, Bonn, Germany, 2014.

Leu, Stefan, Amir Mor Mussery, and Arie Budovsky. "The Effects of Long Time Conservation of Heavily Grazed Shrubland: A Case Study in the Northern Negev, Israel." *Environmental Management* 54, no. 2 (2014): 309–319.

Lewis, S. L., P. M. Brando, O. L. Phillips, G. M. F. Heijden, and D. van der Nepstad. "The 2010 Amazon Drought. Science," 2011.

Liu, John D., and Bradley T. Hiller. "A Continuing Inquiry into Ecosystem Restoration: Examples from China's Loess Plateau and Locations Worldwide and Their Emerging Implications." In *Land Restoration,* 361–379. Elsevier, 2016.

Low, Pak S. "Economic and Social Impacts of Desertification, Land Degradation and Drought." In *White Paper I,* UNCCD 2nd Scientific Conference, 2013.

Lü, Yihe, Bojie Fu, Xiaoming Feng, Yuan Zeng, Yu Liu, Ruiying Chang, Ge Sun, and Bingfang Wu. "A Policy-Driven Large Scale Ecological Restoration: Quantifying Ecosystem Services Changes in the Loess Plateau of China." *PloS One* 7, no. 2 (2012): e31782.

Luino, Fabio. "Sequence of Instability Processes Triggered by Heavy Rainfall in the Northern Italy." *Geomorphology* 66, no. 1–4 (2005): 13–39.

Mainka, Susan A., and Geoffrey W. Howard. "Climate Change and Invasive Species: Double Jeopardy." *Integrative Zoology* 5, no. 2 (2010): 102–11.

Martin, M. "Reforming Forest Tenure: Issues, Principles and Process." FAO, Rome (Italy), 2011.

MaxPlanck Institute. "Hot Air in the Orient," 2016.

McLeman, Robert A., Juliette Dupre, Lea Berrang Ford, James Ford, Konrad Gajewski, and Gregory Marchildon. "What We Learned from the Dust Bowl: Lessons in Science, Policy, and Adaptation." *Population and Environment* 35, no. 4 (2014): 417–40.

Meinzen-Dick, Ruth, Patricia Kameri-Mbote, and Helen Markelova. "Property Rights for Poverty Reduction?" *New York, NY* 10017 (2009).

Millenium Ecosystem Assessment. "Ecosystems and Human Well-Being," 2015.

Mishra, Prasanta Kumar. "Indigenous Technical Knowledge (ITKS) for Efficient Soil and Water Management," 2002.

Miura, Satoru, Michael Amacher, Thomas Hofer, Jesús San-Miguel-Ayanz, and Richard Thackway. "Protective Functions and Ecosystem Services of Global Forests in the Past Quarter-Century." *Forest Ecology and Management* 352 (2015): 35–46.

Montanarella, L., Scholes, R., and Brainich, A. "The IPBES Assessment Report on Land Degradation and Restoration." Bonn, Germany: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2018).

Montgomery, David R. "Soil Erosion and Agricultural Sustainability." *Proceedings of the National Academy of Sciences* 104, no. 33 (2007): 13268–72.

Mor-Mussery, A., S. Leu, and A. Budovsky. "Modeling the Optimal Grazing Regime of Acacia Victoriae Silvopasture in the Northern Negev, Israel." *Journal of Arid Environments* 94 (2013): 27–36.

Mortimore, Michael, Simon Anderson, Lorenzo Cotula, Jonathan Davies, Kristy Faccer, Ced Hesse, John Morton, Wilfrid Nyangena, Jamie Skinner, and Caterina Wolfangel. "Dryland Opportunies: A New Paradigm for People, Ecosystems and Development." International Union for Conservation of Nature (IUCN), 2009.

Munang, Richard, Ibrahim Thiaw, Keith Alverson, Jian Liu, and Zhen Han. "The Role of Ecosystem Services in Climate Change Adaptation and Disaster Risk Reduction." *Current Opinion in Environmental Sustainability* 5, no. 1 (2013): 47–52.

NASA. "NASA Finds Drought in Eastern Mediterranean Worst of Past 900 Years," March 1, 2016.

Nielsen, Thomas Theis, and H. K. Adriansen. "Government Policies and Land Degradation in the Middle East." *Land Degradation & Development* 16, no. 2 (2005): 151–61.

Oldeman, L. R., R. U. Hakkeling, and W. G. Sombroek. "World Map of the Status of Human-Induced Soil Degradation: An Explanatory Note" International Soil Reference and Information Centre, Wageningen (1990).

Pachauri, Rajendra K., Myles R. Allen, Vicente R. Barros, John Broome, Wolfgang Cramer, Renate Christ, John A. Church, Leon Clarke, Qin Dahe, and Purnamita Dasgupta. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* IPCC, 2014.

Pagiola, Stefano, Natasha Landell-Mills, and Joshua Bishop. "Market-Based Mechanisms for Forest Conservation and Development." *Selling Forest Environmental Services. Market-Based Mechanisms for Conservation and Development* (2002), 1–13.

Pinto, Severino, Felipe Melo, Marcelo Tabarelli, Aurélio Padovesi, Carlos Mesquita, Carlos de Mattos Scaramuzza, Pedro Castro, Helena Carrascosa, Miguel Calmon, and Ricardo Rodrigues. "Governing and Delivering a Biome-Wide Restoration Initiative: The Case of Atlantic Forest Restoration Pact in Brazil." *Forests* 5, no. 9 (2014): 2212–29.

Publications, World Bank. *Turn down the Heat: Confronting the New Climate Normal.* World Bank Publications, 2014.

Pye-Smith, Charlie. *The Quiet Revolution: How Niger's Farmers Are Re-Greening the Croplands of the Sahel.* World Agroforestry Centre (2013).

Qadir, Manzoor, Emmanuelle Quillérou, Vinay Nangia, Ghulam Murtaza, Murari Singh, Richard J. Thomas, Pay Drechsel, and Andrew D. Noble. "Economics of Salt-induced

Land Degradation and Restoration." In *Natural Resources Forum,* 38:282–95. Wiley Online Library, 2014.

———. "Economics of Salt-induced Land Degradation and Restoration." In *Natural Resources Forum,* 38:282–95. Wiley Online Library, 2014.

Qian, Weihong, Lingshen Quan, and Shaoyin Shi. "Variations of the Dust Storm in China and Its Climatic Control." *Journal of Climate* 15, no. 10 (2002): 1216–29.

Reed, M. S., and Stringer, L. "Climate Change and Desertification: Anticipating, Assessing & Adapting to Future Change in Drylands-Impulse Report. In 3rd UNCCD. Scientific Conference. Cancun, Mexico: Agropolis International and Groupe CCEE," 2015.

Renaud, Fabrice G., Karen Sudmeier-Rieux, and Marisol Estrella. *The Role of Ecosystems in Disaster Risk Reduction*. United Nations University Press, 2013.

Rodrigues, Ricardo R., Renato A. F. Lima, Sérgius Gandolfi, and André G. Nave. "On the Restoration of High Diversity Forests: 30 Years of Experience in the Brazilian Atlantic Forest." *Biological Conservation* 142, no. 6 (2009): 1242–51.

Safriel, U. N. "Dryland Development, Desertification and Security in the Mediterranean." In *Desertification in the Mediterranean Region: A Security Issue NATO Security through Science Series*, eds. W. G. Kepner, J. L. Rubio, D. A. Mouat, and F. Pedrazzini, 227–250. Netherlands: Springer (2006).

Scholes, R., L. Montanarella, A. Brainich, N. Barger, B. ten Brink, M. Cantele, B. Erasmus, J. Fisher, T. Gardner, and T. G. Holland. "Summary for Policymakers of the Thematic Assessment Report on Land Degradation and Restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services." *IPBES Secretariat: Bonn, Germany* (2018), 1–31.

Selvaraju, Ramasamy. "Implications of Climate Change for Agriculture and Food Security in the Western Asia and Northern Africa Region." In *Climate Change and Food Security in West Asia and North Africa,* 27–51. Springer, 2013.

Shaxson, Francis, A. H. Kassam, Theodor Friedrich, Bob Boddey, and Adewale Adekunle. "Underpinning Conservation Agriculture's Benefits: The Roots of Soil Health and Function." In *Main Background Document for the Workshop on Investing in Sustainable Crop Intensification: The Case for Improving Soil Health,* 22–24, 2008.

Shyamsundar, Priya, Sofia Ahlroth, Patricia Kristjanson, and Stefanie Onder. *Understanding Forests' Contribution to Poverty Alleviation: A Framework for Interventions in Forested Areas.* The World Bank, 2018.

Shyamsundar, Priya, and Rucha Ghate. "Rights, Rewards, and Resources: Lessons from Community Forestry in South Asia." *Review of Environmental Economics and Policy* 8, no. 1 (2014): 80–102.

Soares-Filho, Britaldo, Rafaella Silvestrini, Daniel Nepstad, Paulo Brando, Hermann Rodrigues, Ane Alencar, Michael Coe, Charton Locks, Letícia Lima, and Letícia Hissa. "Forest Fragmentation, Climate Change and Understory Fire Regimes on the Amazonian Landscapes of the Xingu Headwaters." *Landscape Ecology* 27, no. 4 (2012): 585–598.

Stevenson, James, Bernard Vanlauwe, Karen Macours, Nancy Johnson, Lakshmi Krishnan, Frank Place, David Spielman, Karl Hughes, and Paul Vlek. "Farmer Adoption of Plot- and Farm-Level Natural Resource Management Practices: Between Rhetoric and Reality." *Global Food Security* 20 (2019): 101–4.

Stocking, Michael. "The Cost of Soil Erosion in Zimbabwe in Terms of the Loss of Three Major Nutrients," 1986.

Stoorvogel, J. J., EoM A. Smaling, and B. H. Janssen. "Calculating Soil Nutrient Balances in Africa at Different Scales." *Fertilizer Research* 35, no. 3 (1993): 227–35.

Suisse, Credit. "McKinsey, 2016." *Conservation Finance. From Niche to Mainstream: The Building of an Institutional Asset Class. Credit AG and McKinsey Center of Business and Environment,* n.d.

Tal, Alon. "Rethinking the Sustainability of Israel's Irrigation Practices in the Drylands." *Water Research* 90 (2016): 387–94.

The Epoch Times. "China's Great Green Wall Proves Hollow," July 29, 2009.

Tilahun, M., J. Barr, E. Apinidi, Z. Zommers, G. Lund, A. Vuola, E. Mugatana, A. Singh, and P. Kumar. *The Economics of Land Degradation: Benefits of Action Outweigh the Costs of Action in Africa.* Report prepared for the ELD Initiative, in publication, 2015.

Troya, Roberto, and Randy Curtis. "Water: Together We Can Care for It! A Case Study of a Water-Shed Conservation Fund for Quito, Ecuador." *The Nature Conservancy, Arlington, VA,* 1998.

UNCCD (United Nations Convention to Combat Desertification). "LDN Country Profiles," 2018.

———. "Global Land Outlook." UN Convention to Combat Desertification Bonn, 2017.

———. "Land Degradation Neutrality TRANSFORMATIVE ACTION, Tapping Opportunities," 2017.

———. "LDN Fund Officially Launched," 2017. http://www2.unccd.int/news-events/ldn-fund-officially-launched

———. Zero Net Land Degradation. *United Nations Convention to Combat Desertification.* Bonn, 2012.

———. 1994. http://www.unccd.int/convention/text/convention.php.

UNEP, "Status of Desertification and Implementation of the United Nations' Plan of Action to Combat Desertification," UNCED Part I, 1996.

UNEP. "GEO-5: Global Environment Outlook: Environment for the Future We Want. United Nations Environment Programme (UNEP), Nairobi," 2012.

———. "Sudan Post-Conflict Environmental Assessment," 2007.

UNEP, WMO. "UNCCD Global Assessment of Sand and Dust Storms." *United Nations Environment Programme, Nairobi,* 2016.

United Nations. "United Nations Population Division. World Population Prospects: 2017 Revision," 2017.

USDA-NRCS. "Soil Map and Soil Climate Map." Soil Science Division, World Soil Resources, Washington D.C., 1998.

Valatin, Gregory, and Colin Price. "How Cost-Effective Is Forestry for Climate Change Mitigation?" In *Challenges and Opportunities for the World's Forests in the 21st Century,* 297–339. Springer, 2014.

Verdone, Michael, and Andrew Seidl. "Time, Space, Place, and the Bonn Challenge Global Forest Restoration Target." *Restoration Ecology* 25, no. 6 (2017): 903–11.

Webb, Nicholas P., Nadine A. Marshall, Lindsay C. Stringer, Mark S. Reed, Adrian Chappell, and Jeffrey E. Herrick. "Land Degradation and Climate Change: Building Climate Resilience in Agriculture." *Frontiers in Ecology and the Environment* 15, no. 8 (2017): 450–59.

Wired. "The Green Wall of China," April 2003.

World Bank. "Hashemite Kingdom of Jordan Country Environmental Analysis," 2009.

———. "Forest Action Plan FY16–20 (No. 106467)," 2016.

———. "World Bank Annual Report 2016," 2016.

———. "Beyond Scarcity: Water Security in the Middle East and North Africa, MENA Development Report" (2018). https://openknowledge.worldbank.org/handle/10986/27659

World Bank and Institute for Health Metrics and Evaluation (IHME). "The Cost of Air Pollution: Strengthening the Economic Case for Action." Washington: World Bank Group, 2016.

World Resources Institute. "Roots of Prosperity. The Economics and Finance of Restoring Land," 2017.

Wunder, Sven. "Payments for Environmental Services: Some Nuts and Bolts," 2005.

Young, Anthony. *Land Degradation in South Asia: Its Severity, Causes and Effects upon the People*. FAO, 1994.

Zomer, Robert J., Henry Neufeldt, Jianchu Xu, Antje Ahrends, Deborah Bossio, Antonio Trabucco, Meine Van Noordwijk, and Mingcheng Wang. "Global Tree Cover and Biomass Carbon on Agricultural Land: The Contribution of Agroforestry to Global and National Carbon Budgets." *Scientific Reports* 6 (2016): 29987.

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