Leveraging Urban Resilience

for Sustainable Cities in the Arab World

Written by:

Karim Elgendy

Hussein Al Kisswani

FRIEDRICH EBERT STIFTUNG

Leveraging

Urban Resilience

for Sustainable Cities in the Arab World

The Hashemite Kingdom of Jordan
The Deposit Number at the National Library
(2019/12/6373)

333.794

Elgendy, Karim Omar

Leveraging Urban Resilience / Karim Omar Elgendy, Hussein Hussam Kiswani - Amman: Friedrich-Ebert-Stiftung For Publishing and Distribution, **2019**

(24) p.
Deposit No.: 2019/12/6373
Descriptors: /Leveraging//Sustainable Cities//Urban Systems//Arab World/

ISBN: 978-9923-759-03-5

1.0 Table of Contents 1

2.0 Urban Sustainability 3

2.1 Introducing Urban Sustainability 3

2.2 Urban Sustainability in the Arab World 4

3.0 Urban Resilience 6

3.1 Introducing Urban Resilience 6

3.2 Urban Resilience in the Arab World 6

4.0 The Current State of Urban Resilience and Urban Sustainability in the Region 8

5.0 Climate Change in the Arab World 11

5.1 Climate change effects in the Arab World 11

5.2 Climate Change Impacts on the cities of the Arab World 13

6.0 Integrating Urban Resilience and Urban Sustainability 16

6.1 Connections and Contradictions Between Urban Resilience and Urban Sustainability in the Arab World 16

6.2 Recommendations for Urban Systems and Assets to Improve Urban Resilience and Sustainability in Cities of the Arab World 17

6.2.1 Energy 17

6.2.2 Water 18

6.2.3 Mobility 18

6.2.4 Communication and Information Technology 18

6.2.5 Food 19

6.3 Exploring Synergies between Urban Systems 21

6.4 Conclusion 23

2.1 Introducing Urban Sustainability

The urban environment of cities plays a major role in shaping the way we live and work. In a highly urbanized world, the urban environment has become a fundamental component to how we use our resources, how we develop our economies, and how we interface with the local and global natural environments.

The complex urban systems of global cities play a major role in that. Buildings, for example, determine how much energy and water we use to maintain thermal comfort and wellbeing, while transportation systems regulate the energy required for mobility and how much pollution is emitted in the process. In 2017, it was estimated that 64% of total energy use globally is attributed to the built environment, with 36% of energy used in buildings, while 28% is linked to transportation.[1]

Despite the apparent state of flux in cities, most components of the urban environment have a particularly long lifespan. A road network for example, can last for decades if not centuries, while buildings can have a lifespan of over 50 years. This means that decisions taken in the planning of cities as well as the design of buildings and urban systems continue to shape the sustainability of our cities for decades after they had been taken. It also suggests that if the designed urban environment lacked sustainability, the associated economic development and resource consumption levels can remain locked-in for decades until their urban foundations are addressed.

In this context, urban sustainability can be defined as a city's ability through its location, climate, size, density, and the organization of its urban systems and urban assets, to reduce its overall environmental footprint and its dependence on resources from its surrounding hinterland.

A sustainable city can thus refer to a city that has a number of features that support these goals. A city could have a high urban density, a moderate climate, or access to local renewable energy potential that allow it to reduce its fossil energy use. It can also describe a city that optimizes its water usage and only relies on renewable freshwater sources where available.

Since reducing a city's overall environmental footprint includes reducing its carbon emissions and its contribution to climate change, urban sustainability has also come to mean measures to reduce these emissions in cities. In an increasingly urbanized world where cities are responsible for 70% of all carbon emissions,[2] urban sustainability is considered a major climate change mitigation measure.

In the context of cities of developed countries, the main driver behind the current movement towards urban sustainability is the need to adjust existing urban settlements in a manner that maintains economic growth while reducing the negative impact of such growth on the global and local environments and mitigating the resultant environmental imbalances such as climate change.

1 Global Alliance for Building and Construction, 2018 Global Status Re-port.
https://globalabc.org/uploads/media/default/0001/01/3e7d4e8830bfce23d44b7b69350b2f8719cd77de.pdf
(Accessed: 01.07.2019)

2 C40, Why Cites,
https://www.c40.org/why_cities
(Accessed: 01.07.2019)

This stemmed from the view that the current environmental imbalances were not necessarily caused by economic growth, but were largely due to its excessive footprint; the associated energy and resource consumption and the resultant levels of carbon emissions, as well as damage caused to ecosystems by consumption and urbanization.

According to this outlook, the economic, environmental (urban), and social structures of cities and urban environments must be adjusted in a way that rectifies these environmental imbalances but does not harm economic growth.

Efforts and aspirations to achieve this delicate balance in developed countries manifest themselves in different sectors in which urban settlements have an impact on the environment. Sustainable transportation for example, represents an attempt to balance the need for urban mobility - as an enabler for urban economic growth - with reduced energy use, pollution, and carbon emissions. In the same way, sustainable buildings – also known as green buildings - are indoor environments that seek to balance human thermal comfort and wellbeing with reduced energy, water, and material resource consumption.

This notion of sustainable urban development also posits that the ultimate goal of this gradual transition of existing urban settlements – and indeed the creation of new models of urban settlements- is to create urban environments that can be sustained in perpetuity while providing for human needs and maintaining economic growth. It envisages an urbanism that would remain as close as possible to a steady state with minimal need for new resources and with minimal levels of environmental impact, for example: zero carbon emissions, and minimal damage to ecosystems.

2.2 Urban Sustainability in the Arab World

As this urban sustainability model was exported to the Arab World (the Arab countries of the Middle East and North Africa) amongst other developing nations, its supporters soon recognized the unique needs of cities of the region and the different challenges urban sustainability faces in this regional context.

Like many developing countries, cities in the Arab World face many structural and systemic challenges including poor resource efficiency, inadequate infrastructure, inefficient urban systems, urbanization sprawl, pollution, and congestion. As a result many of these cities are struggling to provide adequate urban environments that stimulate economic growth and reap the economic efficiency benefits of urban agglomeration, economies of scale, and the network effect. Some regional cities are even failing in providing basic services to their residents such as power, water, mobility, communication, and food.

The cities of the Arab World also have unique environmental and socio-economic conditions that require bespoke solutions for urban and other environmental sustainability challenges, not to mention social and economic sustainability ones. Environmental challenges include the arid backdrop to most of its cities which limit its hinterland and locations at which human settlements can develop, affect its water security, and consequently its food security. The region's limited share of water and biocapacity and its harsher climate, altogether represent an environmental barrier to the growth of its cities.

Socio-economic challenges, on the other hand, include rapid population growth, rural to urban migration, refugees, urbanization, undiversified and rentier economies, large unregulated and informal sectors, political instability, and conflicts.

A unique approach is thus required for urban sustainability in cities of the Arab World. One that is significantly different from the approach of developed countries and that far exceeds what was offered to developing countries by the Kyoto Protocol's Clean Development Mechanism.[3]

3 The Clean Development Mechanism (CDM) is a mechanism introduced by the Kyoto Protocol for developing emission eduction projects in developing countries to earn certified emission reduction credits, which can be traded and used by industrialized countries to meet part of their emission reduction targets.
The Kyoto Protocol expires, together with the CDM, in 2020.

3.1 Introducing Urban Resilience

As the scientific debates on climate change evolved in recent years, a consensus has emerged that some impacts of climate change are, in fact, inevitable. This prompted the global community to focus its climate efforts on both mitigation and adaptation; mitigating the sources of climate change, and implementing climate adaptation measures to limit the impacts of climate change on urban and natural environments.

The relatively recent notion of urban resilience emerged in this context as a climate change adaptation measure. As the world's population continues its trend towards urbanization, the climate change risks facing cities – as large concentrations of people and man-made systems in limited geographic areas - are becoming more critical.

Yet the definition of urban resilience soon expanded beyond urban climate change adaptation. Urban resilience now has a wider definition which encapsulates all issues pertaining to the ability of a city to withstand different shocks and stresses, and to quickly return to normal function.[4] This definition includes climate change impacts as well as non-climate-related shocks and stresses which affect the built environment such as earthquakes and tsunamis.

Extreme weather events of recent years – especially hurricanes Katrina and Sandy in the United States - have brought urban resilience to fore of the global urbanism discourse, highlighting the importance of maintaining resilient urban systems and assets in our growing human settlements. They especially highlighted the need for spare capacities in critical urban systems - including energy, water, mobility, food, and communication systems - in case they are faced with long-term stresses or sudden shocks, be they natural or man-made.

3.2 Urban Resilience in the Arab World

In the Arab World, the notion of urban resilience has only recently made inroads into policy discussions in a small number of cities (namely Amman, Byblos, Luxor, and Ramallah). However, it is yet to become part of the public discourse in a small number of cities despite being evidently lacking across many of their urban systems.

Many cities in the Arab World continue to struggle with long-term stresses stemming from resource scarcity, water scarcity, energy insecurity, and food insecurity. Other cities are susceptible to short-term shocks, such as stormwater flooding either due to their location and geography or due to their urban planning.

4 100 Resilient Cities, What is Urban Resilience?
http://www.100resilientcities.org/resources/
(Accessed: 20.09.2017).

Yet despite the risks faced by cities, officials from national governments and city administrations have largely avoided – and in some cases actively discouraged - public discourse relating to climate change adaptation and urban resilience. Such a position was attributed to concerns that highlighting the lack of resilience in a city might have a negative impact on foreign and domestic investments into its infrastructure and built environment.

Cities of the Arab World face a wide range of urban resilience challenges that are hindering their development and placing them under continuous and growing stresses. Prime among these challenges is the limited flexibility and diversity of their urban systems.

For decades, regional cities maintained undiversified energy sources, relying on one or two primary energy sources for their electricity mix. They have also retained undiversified water sources, with many cities dependent on two water sources for all their water uses.

In addition, the region's cities – with very few exceptions - lack adequate public transportation networks and are largely dependent on private vehicles. Where public transportation networks do exist, they suffer from limited ridership which limits the diversification of the city's transportation modal split. Low density urbanism in the Arab World has also failed to encourage non-motorized mobility such as walking and cycling.

This lack of mobility diversification has limited urban resilience by creating bottlenecks and risks that place the entire system under stress. A vehicle-dependent transportation network, for example, is more at risk of large-scale congestion than one that also has parallel public transportation networks. In addition, dependence on undiversified urban systems puts cities at increased risk of failure if a sole critical system (e.g. the water or electricity networks) fails without redundancy, compared to a systems that is dependent on multiple parallel networks.

The region's cities also have more than their fair share of unplanned and informal urban areas, which in cities such as Cairo are home to the majority of city residents. While urban informalities can be found in other regions, cities of the Arab World have also witnessed the emergence of informal urban systems such as water, electricity, and waste management systems. Lebanese cities such as Beirut are a case in point, where all urban systems and municipal services (including water, electricity, and waste) are less than adequate and are supplemented by an informal infrastructure of small privately-owned networks.

The region's cities also face a structural water scarcity due to the disparity between available freshwater resources at their geographic location and the continuous population growth they are experiencing, leading to increased stresses on urban development (as in the case of Amman and Beirut) and increased risks of droughts (as is the case in Sana'a).

And while cities in energy-rich Gulf Cooperation Council countries (GCC)[5] have opted for an energy-intensive desalination infrastructure to mitigate their extreme water scarcity, this approach brought about its own resilience challenges. For while desalination shifted the stress from the GCC cities' water systems onto their robust energy systems, maintaining resilient water systems that depend on desalination has also proven difficult due to the limitations of water storage capacity and the associated vulnerability, particularly when faced with a severe shock or an emergency. It is estimated that all GCC countries have water storage capacities that equates to less than one week of consumption.[6]

5 Gulf Cooperation Council countries (GCC) include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

6 AlRukaibi, Duaij, Water resources of GCC countries.

Other regional urban resilience challenges relate to the impact of urban development and increasing urbanization on the region's climates. In a region where on average of 58% of the population lives in urban areas, and where many countries have an urbanization rate that exceeds 80% (e.g. GCC countries),[7] urbanization impacts on the creation of an Urban Heat Island effect[8] in cities cannot be overstated, especially considering their average and maximum temperatures. Other impacts of urban development include the negative impact on soil permeability, especially in cities where thunderstorms are common and stormwater management systems are inadequate.

Some resilience challenges are linked to local resource management. These include poor management of ground water aquifers which suffer from over-extraction and intrusion of sea water, and the poor management of coastlines in coastal cities which compounds coastal risks.

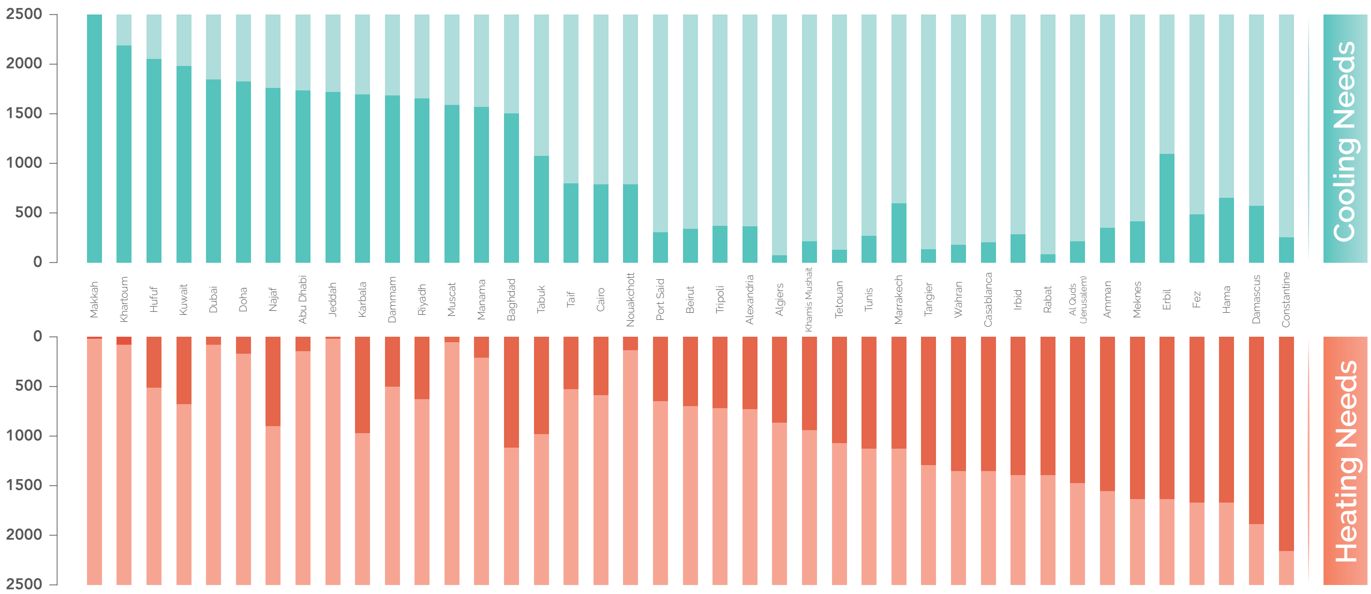


Figure 1: *Heating and Cooling Degree days for Arab World Cities showing cities with high heating and cooling needs, expressed in in Degree Days*
Graphics: *Karim Elgendy.*

While the list of resilience challenges listed above might be enough for most cities to contend with, cities of the Arab World also face a number of urban sustainability challenges.

Despite emerging in locations that had enough water, biocapacity, and a more moderate climate than their surroundings, many of the Arab World's cities are still characterized with relatively high temperatures which has resulted in higher demands for cooling and heating.

Many of the region's cities also lack the urban density required for sustainable urbanism. Cities of North Africa, the Levant and Iraq have an average urban density that is less than 60% of the density required for sustainable neighborhoods according to UN Habitat, while GCC cities having very low urban densities, with an average that is a mere 20% of the recommended density.[9]

---

7 The World Bank Data, https://data.worldbank.org/

8 The Urban Heat Island Effect describes the process where ambient temperatures of built up areas become higher than nearby rural areas

9 Sustainable neighborhood planning requires a density of 15,000 people per square kilometer (or 150 people hectare). Source: UN Habitat, Discussion Note 3: Urban Planning: A New Strategy for Sustainable Neighbourhood Planning: Five Principles, May 2014.

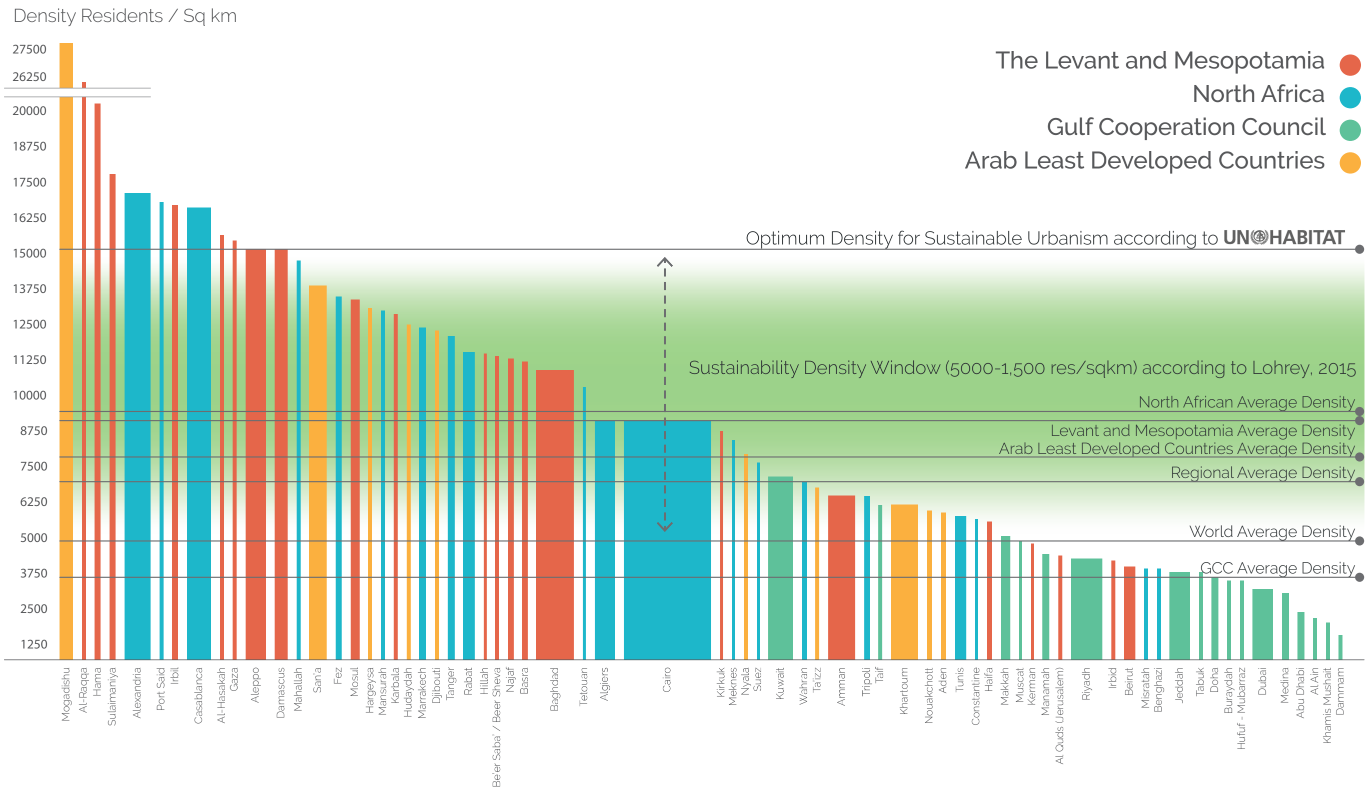


Figure 2: *Density of Regional Cities with Populations above 500,000 (Horizontal scale of bars indicates relative population size)*
Graphics: *Karim Elgendy.*

Many cities also lack an efficient street network that works not only for vehicles and public transportation but also supports walkability and bikeability. Such a street network is not only critical for establishing street hierarchy and supporting sustainable transportation, but it also shapes the urban form of the city and sets the developments of urban blocks, buildings, and open spaces.[10]

In addition, many cities of the region are particularly inefficient in their use of natural resources such as energy (in space cooling, heating, and ventilation) and water (in domestic water use and landscape irrigation). Waste management is particularly inefficient due to the lack of recycling or composting of waste, and the lack of adequate waste management. This poor waste management led to an increased demand for new resources which - in turn- led to a drop in overall resource efficiency. The lack of adequate and reliable public transportation systems coupled with highly subsidized fuel prices have also led to an increased reliance on energy-inefficient personal vehicles.

10 Ibid.

5.1 Climate change effects in the Arab World

In addition to existing urban resilience and urban sustainability challenges, the region's cities face significant future climate change challenges, which can compound the existing challenges described above.

According to the World Bank the MENA region is particularly vulnerable to climate change impacts.[11] The climate change risks it faces are also disproportionate to the region's share of both the global population and the global economy.

An increase in average and maximum temperatures is expected across the region due to climate change. By the end of the century, the region is expected to witness an average temperature increase between 1 - 3˚C under climate change model RCP 4.5 and 2 - 5˚C under RCP 8.5. Maximum temperatures are also projected to increase from 43 - 50˚C by the end of the century.[12] In fact, a warming of approximately 0.2˚ C per decade has already been observed every decade between 1961–1990, and at a faster rate afterwards, combined with an increase in frequency of extreme temperatures.[13]

The strongest warming is projected along the Mediterranean coast, while some inland regions in Algeria, Libya and Egypt, are projected to witness 3˚C warming by 2100 under a 2˚C climate change scenario. Alarmingly mean summer temperatures are also expected to increase by 8˚C in parts of Algeria, Saudi Arabia and Iraq by 2100, under a 4˚C scenario.[14]

A recent study of the effect of increasing temperature and relative humidity around the Gulf has also raised the prospects of potentially fatal conditions for cities along its southern coast under RCP 8.5. According to the study, maximum wet bulb temperatures (a combined metric of temperature and humidity) could reach unprecedented levels by the end of the century that could exceed the threshold of human adaptability. In other words, under the business-as-usual scenario outdoor conditions in those coastal areas could be so extreme at certain points during the year that it might be lethal to be outdoors for a few hours.[15]

Changes to precipitation level are also projected across the Arab World. It is expected that rainfall will be reduced in Maghreb, and the Levant. Countries along the Mediterranean coast, notably

11 World Bank, Adaptation to Climate Change in the Middle East and North Africa Region http://web.worldbank.org/archive/website01418/WEB/0__C-152.HTM *(Accessed 30.06.2019)*

12 ESCWA, Climate Projections and Extreme Climate Indices for the Arab Region, 2015.

13 World Bank 2014. Turn Down the Heat: Confronting the New Climate Normal. Washington, DC: World Bank. License: Creative Commons Attribution—NonCommercial—NoDerivatives 3.0 IGO (CC BY-NC-ND 3.0 IGO). and Tolba M. and Saab W. 2009. Arab Environment: Climate Change, Impact of Climate Change on Arab Countries. Report of the Arab Forum for Environment and Development (AFED)

14 World Bank. 2014. Turn Down the Heat: Confronting the New Climate Normal. Washington, DC: World Bank. License: Creative Commons Attribution—NonCommercial—NoDerivatives 3.0 IGO (CC BY-NC-ND 3.0 IGO).

15 Jeremy S. Pal and Elfatih A. B. Eltahir. 2015. Future temperature in southwest Asia projected to exceed a threshold for human adaptability. Nature Climate Change.

Morocco, Algeria, and Egypt, are all projected to receive substantially less rain under a 4˚C scenario. At the same time it is expected that there will be an increase in moisture delivery to the southern parts of the region (which are already under the influence of monsoon systems), particularly in the southern Arabian Peninsula (Yemen, Oman). However, the contribution of increased precipitation in more water availability would be counteracted by concurrent increase in temperature, causing higher rate of evaporation.

Water resources availability is thus expected to be the primary climate change challenge facing the region, with global changes in precipitation patterns projected to cause a decrease in water availability in most of the Arab World by 15% under a 2˚C scenario and 45% under a 4˚C scenario.[16]

The same research that mentioned above indicates that with the increase in temperatures, water flow in the Euphrates may decrease by 30% and the flow of the Jordan River by 80% before the end of the century. Additionally, snow surface in the mountain areas in Morocco, Algeria, Lebanon, Syria, Iraq, and Turkey plays a major role in water supply of the region. With projected reduction in snowfall and snow water storage, peak flows of melt water will shift towards earlier months, with negative impacts for downstream river systems and water availability in distant regions. For example, snowpack in the upper Nahr el Kalb basin in Lebanon is projected to shrink by 40% under a 2˚C climate change scenario, and 70% under a 4˚C scenario. Drought periods would thus occur 15–20 days earlier under a 2˚C scenario, and more than a month earlier under a 4˚C scenario.

Similarly in the Euphrates and Tigris basins, the snow water equivalent in the Taurus Mountains (the amount of water stored in the snowpack) has also been projected to decrease by 55% under the B1 climate change scenario and 87% in the A1F1 climate change scenario by 2071–2099 (relative to 1961–1990) using the CCSM3 global climate model.[17]

This reduction in precipitation is compounded by the fact that 82% of the region's agricultural production is currently rain-fed,[18] which leaves the region highly vulnerable to temperature and precipitation changes, and the associated implications for food security, social security, and rural livelihoods.

Sea level rise will also have a major impact on the Arab World region given the coastal nature of its human settlements. According to a study done for AFED by Boston University's Center for Remote Sensing, a sea level rise of only 1 meter would directly impact 41,500 km2 of the Arab coastal lands. The impacts of sea level rise would be most prominent in Egypt, Tunisia, Morocco, Algeria, Kuwait, Qatar, Bahrain, and the UAE. Sea level rise would affect 3.2% of Arab countries population, a percentage much higher than the global percentage of about 1.28% of the population.

The most vulnerable countries in terms of land mass affected are Qatar, the UAE, Kuwait, and Tunisia where 1 - 3 % of the land mass will be affected by a 1 meter sea level rise. Of these countries, Qatar is by far the most exposed. Under various different sea level rise projections the risks range from

16 World Bank. 2014. Turn Down the Heat: Confronting the New Climate Normal. Washington, DC: World Bank. License: Creative Commons Attribution—NonCommercial—NoDerivatives 3.0 IGO (CC BY-NC-ND 3.0 IGO).

17 Bozkurt, Deniz & Sen, Omer. (2012). Climate change impacts in the Euphrates–Tigris Basin based on different model and scenario simulations. Journal of Hydrology. 480. 10.1016/j.jhydrol.2012.12.021.Bozkurt and Sen, 2013.

18 AFED 2014, Shideed K. ,Mazid A., Owies T., Van Ginkel M. Potential of Rainfed Agriculture and Smallholder Farmers in Food Self-Sufficiency. Chapter 3 , Arab Environment: Food Security

approximately 3% of its landmass (under 1 meter of sea level rise) to 8% (under a 3 meters scenario), and even up to more than 13% of its landmass (under a 5 meters scenario).

Yet Egypt's economy is by far the most vulnerable to the effects of sea level rise on its Gross Domestic Product (GDP): For sea level rise of 1 meter, more than 6% of its GDP is at risk, and rises to more than 12% for sea level rise of 3 meter. When it comes to the agricultural sector, Egypt will be most impacted by a sea level rise. More than 12% of Egypt's best agricultural lands in the Nile Delta are at risk from sea level rise of 1 meter, and this figure rises dramatically to 25% (sea level rise of 3m) and even almost 35% (extreme sea level rise of 5m).

Qatar, Tunisia, and the UAE are also exposed economically, as over 2% of their respective GDPs are at risk for a sea level rise of 1 meter, rising to between 3 and 5% for a sea level rise of 3 meters.[19]

On the socio-economic front, climate change is likely to lead to the loss of traditional incomes leading to further urbanization and additional strain on cities. In some regional countries, crop yields could decrease by up to 30 % at a 1.5–2˚C climate change scenario and by almost 60% at a 3–4˚C climate change.[20]

In fact, there are countries that have already been affected by such climate-induced socio-economic and political changes. Syria and Egypt have both witnessed social, economic, and political events that can be partially attributed to recent changes to their climate. In Syria, the Middle East's driest winter in 2008 in just over a century forced farming communities to abandon rural areas of north-eastern Syria and migrate into the city of Aleppo. There, they became economically impoverished and, politically, disaffected. In Egypt, by 2009, many people had migrated into the metropolis of Cairo from the Nile Delta, one of the world's most populated, fertile areas, responsible for 63% of Egypt's agriculture. This migration and urbanization was also driven by unemployment and poverty, a result of too little water for everyone to rely on income from farming.

5.2 Climate Change Impacts on the cities of the Arab World

As a result of the above mentioned climate change impacts, the region's cities face additional resilience challenges. These include the following:

- A reduction in outdoor thermal comfort due to increased average temperatures. Average temperatures are expected to increase more in inland cities than they would in coastal ones.[21]
- An increase in heat waves[22] due to increase in peak temperatures, with current climate change models forecasting more warming in summer than in winter across the region.

19 Tolba M. and Saab W. 2009. Arab Environment: Climate Change, Impact of Climate Change on Arab Countries. Report of the Arab Forum for Environment and Development (AFED)

20 World Bank. 2014. Turn Down the Heat: Confronting the New Climate Normal. Washington, DC: World Bank. License: Creative Commons Attribution—NonCommercial—NoDerivatives 3.0 IGO (CC BY-NC-ND 3.0 IGO).

21 ESCWA, Climate Projections and Extreme Climate Indices for the Arab Region, 2015.

22 Defined as an increase in above normal temperature frequency.

- An increase in energy demand for space cooling due to increased average and maximum temperatures.

- A reduction in water availability and an increase in the duration of droughts due to reduced precipitation. It is expected that coastal cities of the region, as well as cities near the Atlas mountain range, and alongside the upper Tigris and Euphrates, will experience a reduction in precipitation between 8-10 mm per year by the end of century.[23]

- Urban flooding due to increased variability of precipitation and increased frequency and severity of extreme rain events (e.g. in cities such as Muscat, Jeddah, and Amman). This is compounded by the lack of adequate stormwater infrastructure in regional cities.

- Many coastal cities of the region face additional risks due to their low lying nature and expected sea level rise. This is compounded by the coastal nature of many cities across the region. It is estimated that of the Arab World's 34,000 kilometers of coast, approximately 18,000 kilometers are inhabited within 100km inland.

A study of 136 coastal cities, separating out the socio-economic drivers of vulnerability from the effects of sea-level rise, identified Alexandria, Benghazi, and Algiers as particularly vulnerable to a 0.2 m sea-level rise by 2050. The study projected that, in the event of the failure of flood defenses, the effects of sea-level rise could result in damages worth US $50.5 billion in Alexandria, US $2 billion in Benghazi, and US $0.4 billion in Algiers. Annual losses would increase to US $58 billion, US $2.7 billion and US $0.6 billion with 0.4 m of sea-level rise for these three cities respectively.

- An increase in migration to cities and urbanization leading to increased strain on resources, urban systems, and infrastructure. Even under less extreme climate change scenarios, climate change is expected to lead to increased competition over scarce resources, greater poverty, and forced migration.

- An increase in desertification and loss of fertile lands leading to reduced food security.

- A potential increase in the occurrences of sand and dust storms.

- According to some climate change models, coastal and low lying cities in the Nile delta (e.g. the cities of Alexandria, Port Said, Dumyat, and Rasheed), in North Africa (Moroccan, Algerian, and Tunisian cities), in the GCC countries (e.g. the cities of Dubai, Doha, Manama, Kuwait, and Abu Dhabi), and in Iraq (e.g. the city of Basrah) all face partial inundation by sea level water by the end of the twenty first century. This is compounded in the GCC by the fact that several GCC cities have engaged in developments on backfilled or elevated land extending beyond the natural coastline. These cities amongst other coastal cities are also at risk of increased storms, and many are at risk of sea water intrusion into their ground water aquifers.

Given the gradual nature of climate change, most of the above mentioned future risks are likely to represent long-term gradual stresses on urban systems, which may culminate in catastrophic outcomes (e.g. sea water inundation). However, a small group of these risks (e.g. urban flooding and extreme heat waves), could manifest themselves as extreme events, representing short-term shocks to cities.

23 ESCWA, Climate Projections and Extreme Climate Indices for the Arab Region, 2015

Another observation stands out from the list of challenges above, which is the centrality of water systems to resilience in the region. The relationship between resilience and water is a global one and is best articulated by the argument that 'if mitigation is about energy, adaptation is about water'.[24] But this relationship is even more pronounced in the Arab World. Not only does the global redistribution of fresh water have a particularly negative impact in terms of droughts and reduced precipitation on a region with a mere of 2% of the world's renewable water and some of the world's most water scarce countries. But the region's cities are also disproportionately impacted by sea level rise due to their concentration on coastal areas.

24 Clausen, T. J. and Bjerg, C. The Blue Revolution: Adapting To Climate Change. (2010).

6.1 Connections and contradictions between Urban Resilience and Urban Sustainability in the Arab World

Urban resilience and urban sustainability are two highly interlinked notions with significant overlaps and many urban resilience strategies have urban sustainability co-benefits and vice versa. For example, installing a distributed electricity generation system in a neighborhood using rooftop solar photovoltaic panels integrates resilience into the electricity grid by diversifying generation sources, and reduces overall carbon emissions associated with electricity generation and thus contributes to urban sustainability through mitigation.

Yet, there are some contradictions between the two notions, the most noteworthy of which is the need for redundant systems and spare capacity for resilience which contradicts with urban sustainability principle of resource efficiency. Duplicate systems performing essentially the same function require twice as much materials and embodied carbon as one system.

In cities of the Arab World, the linkages between urban sustainability and urban resilience are more integral and complex. In a region highly susceptible to social and economic shocks and stresses (e.g. rapid population growth, rural to urban migration, refugees, and a conflict-ridden security environment), the theoretical notion described earlier of a steady state of urban sustainability appears unrealistic as a steady sustainable state is simply unachievable at national or city levels.

In addition, urban resilience models of ensuring the city can recover and restore its functionality following shocks and stresses is also poorly suited for the region's cities, for restoring the cities to their prior state means a return to its original unsustainable condition.

In other words, a city in the Arab World cannot achieve long-term resilience without a sustainable approach to building and maintaining its urban systems and assets. A city also cannot be sustainable without the ability to manage shocks and stresses in a way that not only helps it bounce back to its original condition, but would trigger change to a new more sustainable state.[25]

As such, urban resilience in cities of the Arab World could be viewed as a tool for analyzing adaptive change towards sustainability,[26] and an enabler that supports a transition that can meet and address sustainability challenges.

25 Maguire, B. and Cartwright, S. Assessing a Community's Capacity to Manage Change: A Resilience Approach to Social Assessment. Australia, Social Sciences Program, Bureau of Rural Sciences. 2008.
http://www.tba.co.nz/tba- eq/Resilience_approach.pdf
(Accessed: 14.09.2017).

26 Berkes, F., Colding, J. and Folke, C. Navigating Social-Ecological Systems: Building Resilience for Complexity and Change, 2003.

6.2 Recommendations for Urban Systems and Assets to Improve Urban Resilience and Sustainability in cities of the Arab World

To face their current and future challenges, cities of the Arab World need to take an integrated approach to their urban resilience and urban sustainability challenges. An approach which covers both their urban systems and urban assets.

Such an approach should include an integrated strategy for each urban system which utilizes the opportunities within it for resilience responses that can help transition towards sustainability. This strategy could benefit from the following recommendations for urban systems:

6.2.1: Energy

Diversified and decentralized energy systems (including energy generation, storage, distribution, and use) are essential for energy security. Yet the process of energy diversification is also a great opportunity for transitioning towards a more sustainable and efficient energy mix that includes different renewable energy sources (e.g. solar photovoltaics, solar thermal, wind power, hydropower, and biofuels[27]) alongside distributed and reliable base load generation.

Diversifying these energy sources in type and geographic location is also great for resilience to ensure supply continuity if climatic conditions change. This includes a geographically wide application of single energy sources (e.g. solar or wind) to militate against fluctuations in wind or solar radiation in any given location. It also includes the mixing of different energy sources (e.g. wind and solar power) to mitigate against the cyclical nature of solar power.

With regards to energy consumption, the most efficient approach to space conditioning buildings across a district is developing district cooling and heating systems. These systems include a central heating, cooling and ventilation (HVAC) plant and a series of underground tunnels that connect the plant to individual buildings. Given their highly centralized nature, adoption of these district systems should include creating redundancies in the Heating Ventilation and Air Conditioning (HVAC) plant and conveyance in order to improve their resilience. Alternatively, decentralized and highly sustainable HVAC systems such as Solar Cooling can also be explored, offering energy efficiency and a high level of resilience, albeit at higher cost.

The best regional examples for resilience and sustainable energy sources diversification are the efforts of Morocco to diversify its energy sources away from fossil fuel. In its national targets for 2020, Morocco has committed to sourcing 14% of its energy from solar power (including both photovoltaic and concentrated solar power technologies), 14% from wind power, and 14% from hydropower. This equates to an impressive 42% of its national energy use from sustainable sources and a significant reduction to its carbon emissions.[28] At city scale, Dubai presents the only example with a commitment to diversify its energy sources away from fossil fuel by 2050. It plans include 44% from renewable energy source, 6% from nuclear, and 50% from natural gas and coal.

27 One benefit of biofuels is its storage capability which supports its use as a primary source for base load generation. However, the use of biofuel requires careful exploration of the full supply chain of agricultural products and byproducts to ensure that it does not affect food security..

28 Regional Center for Renewable Energy and Energy Efficiency, Arab Future Energy Index™ (AFEX) 2016: Renewable Energy, 2016.

6.2.2: Water

Diversified and secure water systems (including extraction, reuse, desalination, rainwater and wastewater collection, and storage) that are sustainable, efficient, and meet future needs would achieve both water security and water efficiency. Water sources may include combining solar thermal desalination and efficient reverse osmosis desalination. They can also include the treatment of sewage effluent for reuse, and reducing dependence on energy for conveyance by optimizing gravity in the design of the water network. Large-scale water storage should also be considered as a measure to improve resilience where fresh water resources are limited and to balance the loss of snow cap storage on mountains where fresh water is available.

Amongst Arab World cities, Algerian cities have the most diversified and sustainable water sources. The national water network in Algeria currently depends on a mix of fresh surface water, ground water, and desalination, to sources its water supply with more than 90% of its water is sourced sustainably. Libyan cities, on the other hand, have the least diversified and the least sustainable water sources -being almost entirely dependent on ground water from fossil aquifers.[29]

6.2.3: Mobility

A multi-modal mobility system that is integrated, interconnected, more energy efficient, and less motorized offers an opportunity for sustainable and resilient urban mobility. Such multi-modal system could take the form of a high-volume, high-frequency urban rail network integrated together with a feeder bus network, a bike sharing scheme, and a network of shaded pedestrian links at rail stations. A well designed transportation system can reduce energy demand while also reducing the time its users are exposed to heat and extreme weather.

While many regional cities appear to have understood the importance of mass transportation and multi-modal mobility networks, only a few have recently embarked on developing public transportation networks including metro network developments in Dubai, Doha, and Riyadh, and light rail networks in Casablanca and Rabat-Salé.

Stormwater management systems offer both resilience and sustainability opportunities. If designed and sized appropriately for extreme rain events (e.g. using Sustainable Urban Drainage Systems and increased ground permeability) these systems have great resilience benefits in reducing urban flooding and stormwater run-off. They also support sustainability goals such as improving aquifer recharging, and potentially rainwater collection. In regional coastal cities stormwater management systems take on additional benefit in that they project the cities ground water resources. Recharging the aquifer by injecting treated stormwater in combination with a managed reduction in ground water abstraction levels helps limit saltwater intrusion into coastal aquifers.

6.2.4: Communication and Information Technology

A digital infrastructure also carries a great resilience potential in that it provides essential services in emergencies. A resilient digital communication network with sufficient versatility and redundancies that ensures critical communication networks and early warning tools are open at all times, can

29 World Bank, Beyond Scarcity: Water Security in the Middle East and North Africa (Conference Edition), 2017.

prove invaluable during an emergency especially in flooding prone areas. But such a reliable digital communication infrastructure can also support sustainability in reducing the need for physical mobility (via private and public transportation) thus relieving pressuring on transportation networks.

6.2.5: Food

Decentralized food systems that employ sustainable agriculture methods and that use less water for irrigation and energy in processing, transportation, and distribution (e.g. urban agriculture including water-based systems such as hydroponics and aquaponics) can support both food security and sustainable food production. However, it is worth noting that while urban food systems can reduce a city's dependence on its hinter land, they are incapable of supporting urban food security on their own.

Aside from urban systems, fixed urban assets (buildings and urban spaces) also offer great opportunities for transitioning towards urban sustainability and urban resilience. An integrated strategy for urban assets could benefit from the following recommendations:

- An environmentally-responsive urban form can utilize passive design measures to balance urban resilience needs with urban sustainability needs.
- Increased urban density for example, can lead to improvements in energy efficiency by reducing a neighborhood's surface to volume ratio. It can also improve the viability of mass transportation systems as well as outdoor thermal comfort.

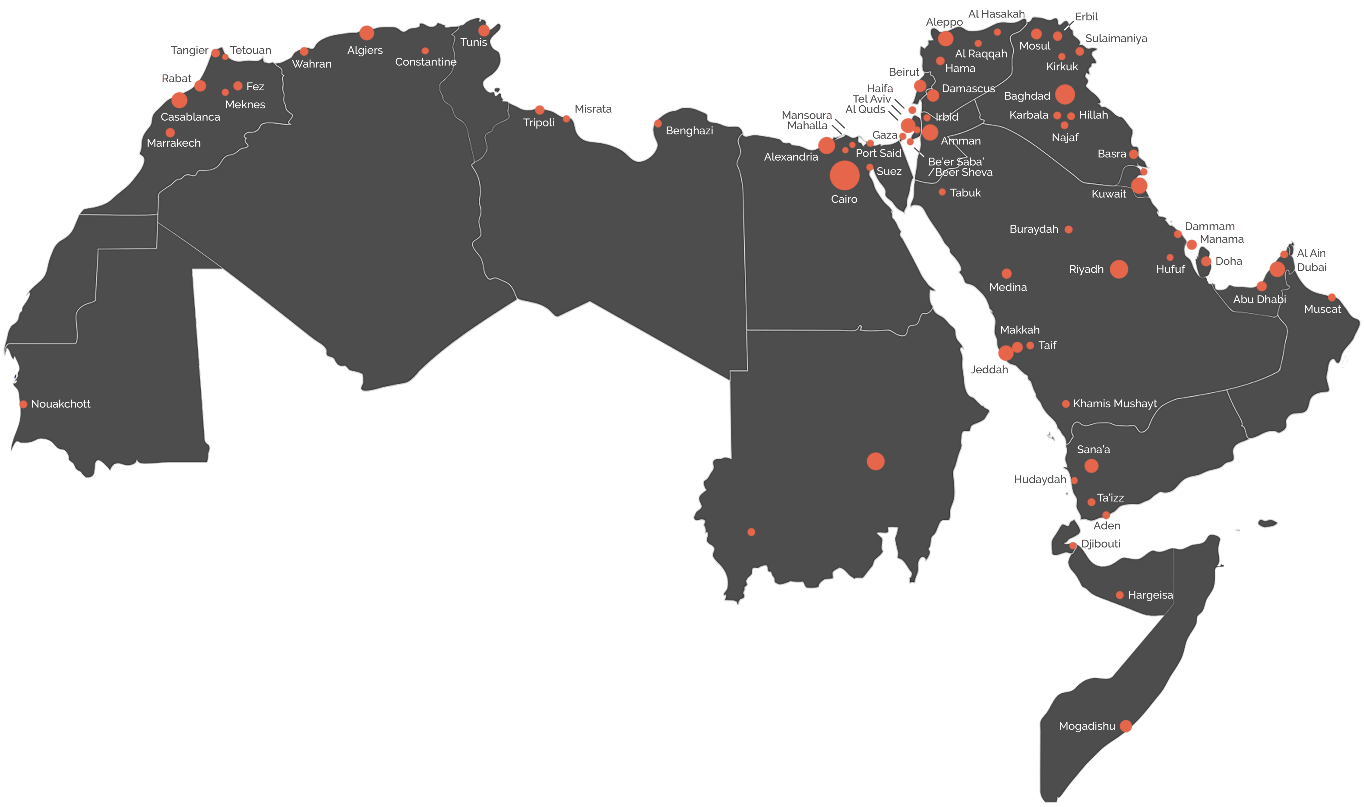


Figure 3: *Map of large cities of the Arab World (with populations larger than 500,000 in 2015). Circled indicate relative population size of cities.*
Graphics: *Karim Elgendy.*

- Similarly, planning a neighborhood to encourage gentle air movement while sheltering from sand and dust storms, can improve outdoor thermal comfort while reducing the need for mechanical ventilation in buildings. Green open spaces can also reduce Urban Heat Island effects thus reducing risks of thermal shocks and improving outdoor comfort.

- Building-scale measures such as optimizing a building's solar geometry to provide ade-quate indoor and outdoor solar protection, and using materials with high reflectivity or incorporating green walls and green roofs, can also reduce cooling energy use in build-ings while limiting a city's Urban Heat Island effect. A good example of activism is the MENA Green Building Council (GBC), which has published many regional and local stud-ies and models for improving urban building structures.[30]

- In addition, cities have unique urban form needs vis-a-vis their climate risks. Coastal cities for example, need an urban form that adapts to sea level rise and storms (e.g. through better coastal management as well as informality upgrades), while inland cities in arid ar-eas need an urban form that is resilient to sand and dust storms and that mitigates against desertification (e.g. using better urban and natural barriers as well as sand filtration).

- Maintaining and enhancing natural assets such as urban ecosystems as nature-based solu-tions (for example by protecting coastal ecosystems and integrating green infrastructure) provide an opportunity for both urban sustainability and urban resilience. Utilizing eco-system services of natural landscapes within and immediately surrounding cities, can im-prove urban sustainability while utilizing natural and local resources. Yet it is critical here that ecosystem functions are preserved and that the carrying capacity of these ecosystems is not exceeded. Urban ecosystems can also make cities more resilient since nature-based adaptation can play a major role in improving the adaptive capacity of a community.

6.3 Exploring Synergies between Urban Systems

In addition to intra-system resilience and sustainability, synergies between urban systems should be also explored. Synergetic relationships between energy, water, stormwater, digi-tal infrastructure, food, and waste systems as well as with urban and natural assets are cru-cial for ensuring the sustainability and resilience of the whole urban system.

At the core of these synergetic relationships lies the water-energy-food nexus, a term that describes the increasingly complex and interrelated nature of our global resources systems. It suggests that water security, energy security, and food security are all inextricably linked and that actions in any one sector usually have an impact on the others.[31]

Despite including urban and non-urban systems, the water-energy-food nexus framework is critical to exploring large-scale synergies between utility systems. It covers the following relationships:

- Energy-Water: Energy is needed for ground water extraction, desalination, treat-ment, conveyance, and distribution, plus waste water disposal. While water is re-quired for the extraction of energy sources and for energy generation (e.g. in creat-ing steam, in cooling towers of power plants, and in hydropower).

- Water-Food: Water is critical for agriculture and animal breeding, while food pro-vides water in the form of virtual water.

- Energy–Food: Energy is needed for the production, processing, transportation, and distribution of food. Agriculture can be used to produce energy (e.g. biofuels and waste to energy).

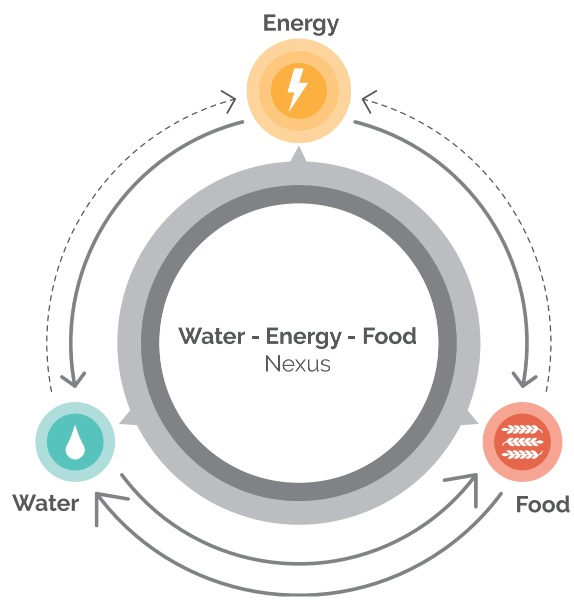


Figure 4: The distorted water–energy–food Nexus in the Arab World. Graphics: Karim Elgendy.

In the Arab World, the water-energy-food nexus has traditionally been distorted and lacking in resilience. With 66% of the world's crude oil reserves, countries of region with an excess supply of fossil energy have often used their trade surplus and their energy resources to support the region's overstretched water and food sector. The water sector has largely suf-fered from high levels of scarcity and over-exploited aquifers, while the food sector has be-come increasingly under stress due to limited soils, desertification, and limited irrigation water.

This support normally took the form of energy subsidies. Reducing energy costs has effec-tively subsidized sourcing freshwater and food production processes. The downside to this is that the entire water-energy-food nexus is now dependent on the energy sector with sig-nificant risks to society if the energy sector encounters a disruptive shock.

31 Food and Agriculture Organization of the United Nations, Water-Energy-Food Nexus http://www.fao.org/energy/water-food-energy-nexus/en/ *(Accessed 14.09.2017).*

Limited rain, fragile soils, and dependence on virtual water (water in the form of food) have also created strong dependencies between water and food systems.

To address the water-energy-food nexus in the region, inter-sectoral policies are required alongside strategic and technical coordination. In addition, innovative solutions that create synergies between utility systems while maximizing efficiency and resilience are required, which may include the following examples:

- Using Treated Sewage Effluent (TSE) in district cooling towers. This technique would significantly reduce fresh water demand but requires additional capital expenditure in erosion resistant equipment as well as additional maintenance.
- - Using seawater in the cooling towers of Concentrated Solar Power plants (CSP). Similar to TSE, this technique would significantly reduce fresh water demand but it al-so requires additional capital expenditure in erosion resistant equipment and needs additional maintenance.

- Combining power generation with thermal and efficient Reverse Osmosis (RO) desalination to maximize synergies between electricity generation and freshwater production.

In this arrangement, spare heat rejected from the power generation processes is used to support thermal desalination processes. During the periods when urban electricity demand drops, electricity from the power plant can be diverted for use to power en-ergy-efficient Reverse Osmosis desalination, with spare steam also used to preheat seawater and to run pumps. Given its diversification and efficiency, this hybrid-cogeneration process improves both the sustainability and resilience of water and energy supplies. Solar desalination can be added to this arrangement to improve its diversity and resilience, while enhancing its sustainability by reducing its dependence on fossil fuels.

- Using organic wastes such as cooking oil, sludge from wastewater, and green waste to generate energy. This reduces overall organic waste diverted to landfills, diversifies energy sources, and reduces dependence on fossil fuels. Organic waste can also be used to create compost to support agriculture and reduce fertilizer use.

- Underground tunnels can be used to divert flood water into streams outside the cit-ies. The same tunnels can also be used for transportation when required, and when the weather permits it.

- Introducing urban agriculture systems into the built environment to limit urban heat island, reduces need for transportation, improve air quality, and increase soil stabili-zation. Soil free agriculture such as hydroponics and aquaponics can also be used in cities where fresh water is available to overcome soil scarcity.

6.4 Conclusion

Cities of the Arab World are critical to the region's sustainable development but are unable to achieve their potential due to a myriad of urban challenges. These challenges require an integrated approach to improve urban development, and to integrate urban sustainability, and urban resilience. Such an integrated approach should also be tailored to the region's needs, not only recognizing its unique environmental and socio-economic conditions, but also the need to improve both resilience and sustainability across all urban systems and as-sets.

The urgent nature of climate change adaptation represents a major challenge for the re-gion's cities. But it also provides us with opportunities. Innovations that have to be done in order to to transform and retrofit urban systems towards resilience, could at the same time develop the cities into cities with better infrastructure on essential services for citizens. This, together with the tabula rasa conditions that exist in several of the region's cities, creates an opportunity for developing urban systems and urban assets that are sustainable and resilient and which maximize the synergies between sustainability and resilience without creating dependencies.

The Arab World has a lot to learn from the successful experiences of other developing coun-tries that embraced urban sustainable development and urban resilience, but it will ulti-mately have to chart its own way if it is to create a sustainable future for its people.

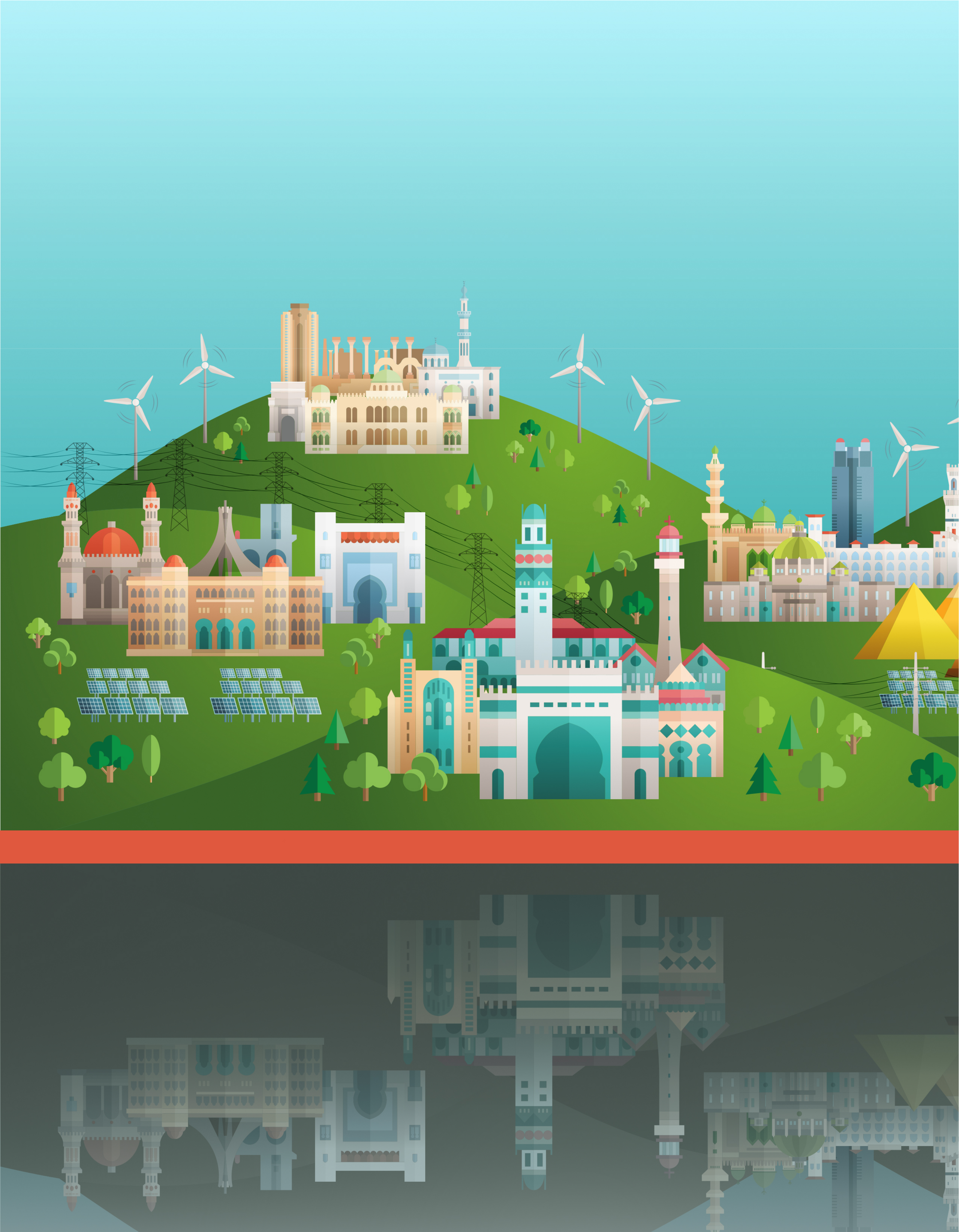
The Hashemite Kingdom of Jordan
The Deposit Number at the National Library
(2019/12/6373)

Published in 2019 by Friedrich-Ebert-Stiftung Jordan & Iraq
FES Jordan & Iraq
P.O. Box 941876
Amman 11194
Jordan

- Email: fes@fes-jordan.org
- Website:www.fes-jordan.org

Not for sale

ISBN: 978-9923-759-03-5



ISBN: 978-9923-759-03-5