OCP POLICY CENTER
THINK • STIMULATE • BRIDGE

Policy Brief

October 2017, PB-17/39

Climate Change and the Water-Energy-Food Nexus in the MENA Region

By Rabi Mohtar

Summary

Understanding the interlinkages between Climate Change and the water-energy-food securities is critical for developing effective strategies to adapt to projected changes and ensure sufficient access to these resources for a growing global population. This Policy Brief identifies some of the key factors and specific climate change impact in each of the water, energy and food sectors and possible adaptation strategies will be explored.

Climate change is already happening; according the Intergovernmental Panel on Climate Change (IPCC), the Earth's temperature has warmed faster in the last 3 decades than ever before since 1850; oceans have warmed around 0.11 C per decade in the last 40 years. The rate of sea level rise is now more than 3 mm per year since the 1990s (due to climate change and other aspects) (IPCC, 2014). These and other changes in climate such as precipitation have sever implications for human systems.

The IPCC has projected that temperatures in the Arab region will rise between 1 to 1.5 degrees °C by 2030 and up to 4 degrees °C by 2100 over parts of the Arab world (IPCC, 2007). Most of the dramatic impact is expected to affect the sub tropics where most of the ESCWA region is located. If adaptation and mitigation policies stay unchanged, it is projected that twenty coastal cities around the world will see devastating impacts from a significant increase in sea level waters; four of them are in north Africa and ME region: Algiers, Beirut, Alexandria and Benghazi. These cities will see significant impacts that have the potential to disrupt coastal agriculture, lifeline, power, telecommunications and transportation sectors (ESCWA 2016; Hallegatte et al., 2013).

Impacts on Water Security

The Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR) climate change projections have shown that the variability of precipitation in the region will be even larger than the temperature changes. With drier conditions predominantly in the Northern Maghreb, different scenarios have shown a drastic reduction in average monthly precipitation (down to 8-10mm) in the coastal regions. It is projected also that dry season will become longer in the MENA region (IPCC, 2007 and ESCWA, 2015).

With these scenarios in mind, it is expected that increase in temperatures and reduction in precipitation will result in a 30-70% reduction in recharge of aquifers in the Mediterranean Coast, impacting the quantity and quality of ground water (Döll and Flörke, 2005). There is a significant reduction effect in surface and subsurface water resources in the MENA region. These reductions will directly influence river flow, instream flow as well as soil water reservoir. The latter will significantly impact food production while the surface water storage will impact our domestic and agricultural water supply.

Therefore climate change will affect the national water security of the countries of this region. In addition, the projected reduction in stream flows will negatively change the potential of countries to generate power through renewable sources (such as hydropower).

Impacts on Energy Security

The estimated higher summer and winter temperatures will impact energy requirements of processes such as groundwater extraction, desalination, as well as the treatment, transfer and distribution of water and energy. For example, cooling energy requirements in desalinitation and power generation are expected to rise considerably with the rise of air temperature. The energy requirements for pumping underground water becomes higher as communities search for available water in deeper grounds. Even though there are currently technological advances that can counteract these higher energy requirements, national plans that look at these savings have not been developed in many parts of the region.

The efficiency, operations and development of new power plants is expected to be impacted by the overall warming of water and air. Also, severe weather events have the potential to severely impact infrastructure and security of energy sector. Enhancing the adaptive capacity of the power production infrastructure can be achieved through an integrated approach. Leaks in the pipe networks ranges between 30 and 45 per cent which adds to the energy and water losses. Infrastructure investments to repair and upgrade these networks are lacking in many countries in the region (ESCWA, 2016).

A few adaptive measures to improve energy system resilience to climate change would include the following:

- Improve power plant efficiency
- Demand management
- Decentralization of power generation
- Storm planning for power plants and refineries
- Build strategic fuel reserves

It is evident that the above measures fit under good energy governance. Accordingly and in general, ***increasing resilience to climate change is the right thing to do, irrespective of the extent of the impact that is projected***. This will increase capacity of communities to grow, thus providing better economic opportunities and incentives.

Looking at climate change impacts on the renewable energy sector, we can expect that the reduction of river flow, change in wind conditions and solar maps will directly affect energy generation; reliance of hydroelectric power will also be disrupted. Projected increases in the activity of extreme weather events could also lead to downing of the power transmission and tower lines; sea level rise will affect many power plants in the Arab region, especially in coastal cities. Also, reduced river stream flow will impact the hydropower production potential in the Arab countries where hydropower already plays a role in the national energy portfolios. This impact has not been quantified but must be included in future studies related to climate change and the water-energy nexus.

Impacts on Food Security

Focusing on impacts of climate change on food security, it is projected to see a decrease of agricultural outputs of up to 21% by 2018 with peak to up to 40% decrease in countries like Algeria and Morocco. Big part of this reduction is due to the rise in temperature and the increase in crop water requirements (Cline, 2007). A lot of these disturbances that are projected in the MENA region are actually higher than the average global impacts of climate change in food security (ESCWA, 2016).

Clearly the impacts on food security will vary from crop to crop; with projected losses of up to 20% in crops such as barley (which is a staple crop in the region) and maize. Impacts on wheat are variable from one region to the other, including a crop reduction between 26-40% in many parts of the Arab world (Eid and El-Mowelhi, 1998). In addition, as production yields are expected to drop, crop water requirements will increase. Some projections calculate seasonal crop water requirement increases of 4% by 2025 and up to 14% for some crops by 2100 (Medany, 2008).

The reduction of precipitation projected decreases soil moisture availability, which therefore reduces the food production in the affected areas. Over 60% of the food produced globally is rain fed; it is then evident that lower precipitation rates will impact food production and adds pressure to the demand of water for irrigation in order to maintain food production. Supplemental irrigation needs impact not only water resources allocation but energy security as a result of higher demands for pumping and irrigation (ESCWA, 2016).

Other impacts of climate change that might affect the water-energy-food securities and must be considered are:

- Dust storm frequency and intensity and in particular the Gulf region of MENA. This will have significant impact on health and future growth in renewable energy (specifically on solar power).

- Changes in agricultural zones and water management. One of the impacts that we will see globally is the shift in these ecological and food production zones. Producers will be forced to change the distribution of the cropping systems and where certain crops are being produced.

- Impact of sea rise on coastal cities where annual losses increase in most optimistic sea level rise average. This will impact many of the Coastal Arab cities including Beirut and Alexandria.

- Last but not least, the impact on human mobility; this will exacerbate the already intense human migration and refugee issues in the region.

Adaptation

There are four elements to be considered when we are discussing adaptation strategies:

- Human development,
- Response capacity building,
- Climate change impact activities
- Managing climate risks

These adaptation strategies as mentioned before are the right way to go for increasing the resilience of communities, with or without adverse climate change impact projections. Starting with human development strategies; for example activities that impact poverty, literacy, gender and pollution prevention would be significantly impacted by climate change. These activities however must be done by governments regardless of climate change impact.

Adaptation strategies that will increase the response capacity building are activities that will determine how quickly communities can rebound back from the effects of natural disasters and climate change effects. These activities target the building and strengthening of institutions, and increase their response capacity. This includes technological approaches as well as tools, such as reforestation to combat landslides (a huge issue around the Mediterranean sea), integrated resources management systems; last but not least weather monitoring stations. It is worth noting here that we do not have sufficient stations, especially in the semi-arid regions where climate variability is huge and more extensive weather monitoring is required.

Energy production from renewable sources such as solar and wind is a major capacity building activity that is logical in this part of the world given the high availability of these resources in the region. It is worth highlighting the vision of the Moroccan government in pushing forward the development of solar plants in dry areas, generating more revenues for agricultural systems in rural areas while increasing resilience to climate change (Schilling, 2012).

Looking into adaptation strategies for management of climate risks, these include implementation of activities that can decrease the impact of climate change. For example, developing drought resistant crops, climate proofing, and the development of disaster response programs. Other adaptation strategies include activities that alleviate the effects of a climate event such as repair of damage to infrastructure and how quickly that can be done.

Climate Change and WEF Nexus Security

Impacts on Water Security:

- Reduced availability of ground water recharge.
- River flow reduction will impact water supply.
- Reduction in stream flow will impact soil moisture availability.
- Crop water requirements will increase therefore more competition for water resources among sectors.

Impacts on Energy Security:

- Higher energy requirements for groundwater extraction, desalination, as well as water treatment, and transfer and distribution of energy.
- Overall warming of air and water will affect the efficiency and operations of power plants.
- Extreme weather events have the potential to cause severe infrastructure damage in the energy sector.
- Changes in river flows will affect the hydropower potential in countries where already this is an important part of their energy portfolio.
- Change in wind conditions and weather will affect production of wind and solar energy.

Impacts on Food Security:

- Decrease of crop yields
- Crop water requirements will increase
- Extreme weather and sea level rise can be devastating to coastal agriculture

Final Remarks

In conclusion, more extreme weather and heat waves are expected in the MENA region; this will have economic implications as well as health and environmental consequences. Climate change impacts on water, energy and food securities are significant therefore a nexus approach to adaptation and mitigation is needed. Decision Support Tools can be used to assess the economic, environmental and social sustainability of technological and policy solutions towards climate adaptation. Addressing climate change and its impacts on water and energy require a multi-stakeholder and a multiscale approach to policymaking. In addition, such an integrated approach can be achieved through creating a regional cooperation and community through which success stories and practices are shared and larger resilience is achieved. Finally, localizing water and food security is imperative for more resilience to climate adaptation; a nexus approach to the management of water resources is key in climate change resilience.

References

Cline, W. R. (2007). Global warming and agriculture: impact estimates by country. Center for Global Development and the Peterson Institute for International Economics. ISBN-13: 978-0-88132-403-7.

Döll, P. and Flörke, M. (2005). Global-Scale estimation of diffuse groundwater recharge. Frankfurt Hydrology Paper 03, Institute of Physical Geography, Frankfurt University, Frankfurt am Main, Germany. Available from https://www.uni-frankfurt.de/45217767/FHP_03_Doell_Floerke_2005.pdf.

Economic and Social Commission for Western Asia (ESCWA, 2015). Climate Projections and Extreme Climate Indices for the Arab Region. Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICAAR). Beirut. E/ESCWA/SDPD/2015/Booklet.2.

Economic and Social Commission for Western Asia (ESCWA, 2016). Developing the Capacity of ESCWA Member Countries to Address the Water and Energy Nexus for Achieving Sustainable Development Goals, Regional Policy Toolkit. United Nations, Beirut. 219 pgs

Eid, H. M. and El-Mowelhi, N. M. (1998, October). Impact of climate change on field crops and water needs in Egypt. In African international environmental conference, Egypt.

Hallegatte, S, and others (2013). Future flood losses in major coastal cities. Nature climate change 3 (9), 802-806.

International Panel on Climate Change (IPCC, 2007). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, C.E. Hanson, Eds., Cambridge: Cambridge University Press. Available from https://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4_wg2_full_report.pdf

International Panel on Climate Change (IPCC, 2014). 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. Geneva, Switzerland.

Medany, M. (2008). Impact of climate change on Arab countries. In Arab environment future challenges, Mostafa Tolba and Najib Saab, eds. Beirut, Lebanon: Arab Forum for Environment and Development. Available from http://www.afedonline.org/afedreport/full%20english%20report.pdf.

About the author, Rabi Mohtar

Rabi H. Mohtar is a Senior Fellow at OCP Policy Center and TEES Endowed Professor at Texas A&M University, College Station, Texas. He is also an Adjunct Professor at Purdue University. He is the Founding Director of Qatar Environment and Energy Research Institute (QEERI) amember of Qatar Foundation, Research and Development and the Founding Director Strategic Projects at Qatar Foundation Research and Development. He was also the inaugural Director of the Global Engineering Programs at Purdue University, West Lafayette, Indiana.

Mohtar's research addresses global resource challenges: developing the Water-Energy-Food Nexus framework linking science to policy, characterizing soil-water medium using thermodynamic modeling and nontraditional water applications for sustainable integrated water management. He is a distinguished alumni of American University of Beirut (2014), recipient of the Ven Te Chow memorial award, International Water Resources association (2015) and Kishida International Award (2010). Mohtar served on the World Economic Forum Global Agenda Councils on Water Security and on Climate Change (2009-2014). He is a governor of World Water Council since 2012. He has published over 200 published manuscripts include peer-reviewed journals, refereed conference proceedings, books and chapters.

About OCP Policy Center

OCP Policy Center is a Moroccan policy-oriented Think Tank whose mission is to contribute to knowledge sharing and to enrich reflection on key economic and international relations issues, considered as essential to the economic and social development of Morocco, and more broadly to the African continent. For this purpose, the Think Tank relies on independent research, a network of partners and leading research associates, in the spirit of an open exchange and debate platform.

The views expressed in this publication are the views of the author.

OCP POLICY CENTER
THINK · STIMULATE · BRIDGE

OCP Policy Center

Ryad Business Center – South, 4th Floor – Mahaj Erryad - Rabat, Morocco
Email : contact@ocppc.ma / Phone : +212 5 37 27 08 08 / Fax : +212 5 37 71 31 54
Website: www.ocppc.ma