



Future Projections of Water Source Availability in the Eastern Mediterranean

Insight on Health and Political Impacts

Abstract: This work projects the future impacts of global climate change on the Eastern Mediterranean countries in general, and on Lebanon, Syria and Israel in specific. It assessed the geographical area and predicted the possible climate related changes which will contribute to the environmental and human health impacts. Possible realistic solutions and prevention plans were set after describing the political impacts of global climate change to avoid wars in the studied area.

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1. Introduction

A predicted environmental crisis will hit the humankind in the coming years. The earth's climate is tremendously increasing especially with the elevated emissions from anthropogenic sources of greenhouse gases. Global warming is currently the most serious issue which is causing political and economic tension among the leaders. It is the most serious problem which leaders from the globe are trying to solve; yet there is much to be done. Scientists are increasingly and constantly warning the leaders about the harmful impacts of global warming. The later will potentially disrupt and destabilize the earth's climate, affecting mankind and their communities. To work out a solution, the problem is dissected into two parts. Initially, the leaders should work on resolving the underlying political, technological and economic problems between the nations before figuring out a solution for the main problem; to decrease the green gas emissions. Currently, in 2012, the impacts of climate change began to appear as many civilizations living in susceptible areas around the globe start adapting to new patterns of excessive rainfall, prolonged droughts and severe weather events. The United Nations has been sponsoring talks with the 194 participating countries, under the United Nations Framework Convention on Climate Change to discuss the impacts of global climate change. Yet, so far, effectively nothing is done to minimize the impacts of global climate change. Where does the Middle East stand in front of the struggles that are faced by developed countries on one side and the top greenhouse gas emitter countries on the other side?

Is water a human right or a commodity? People might have conflicting answers. A river flowing in one country is the ultimate right for its citizens. However, does this give the right of surrounding dryer regions to conquer this water rich country or should their people suffer from limited water resources? What about the ratio of supply and demand of water by the populations. How are people using water? When dealing with the issue of water source availability in a region like the Eastern Mediterranean, enormous questions should be answered and conflicts should be resolved. The objectives of this paper are to predict the future projections of water source availability in the Eastern Mediterranean in general, and in Lebanon, Syria and Israel in specific. The topic will be evaluated from the public health perspective, by which the environmental and human health impacts of global climate change will be addressed. These impacts will be assessed in political terms and prevention plans and possible solutions will be provided to avoid the predicted tensions in the area.

2. Global Climate change

a. Study Area Geography

Water in the [Middle East](#) is a scarce resource, therefore, any disruption or damage affecting it will have serious implications on the region as a whole. We will start by exploring the geography of the studied region. Its climate ranges by seasons where it suffers from warm summers and cold winters. (Emberling, 2010). Starting with Lebanon, it is the smallest among the other countries with an area of 10452Km², but the richest among the others in water. Most of Lebanon's land is mountainous which decline from North to South, the highest reaching nearly 3000m from the sea level. Due to this nature, snow falls on most of Lebanon's area, and it ensures the proper irrigation of the coastal line. Furthermore, [Lebanon](#) is rich with springs which naturally flow from higher altitudes and which are sufficient to generate water flow in the 17 existing rivers. (Eickelpasch, 2007). Therefore, it doesn't suffer from water scarcity as Syria and Israel.

[Syria](#), which makes an area of 185,180km², is the biggest among the three studied countries. Syria is surrounded by Lebanon, Israel, Jordan and Turkey. Its Mediterranean border is low-lying and filled with underground water sources, allowing population's growth and agricultural production due to soil's fertility. The Orontes River constitutes the major life source for people who live in Damascus and its surrounding inland cities. However, the east of the country is dry and more like a desert which doesn't support life (Syria: Geography, Weather, & Wildlife, 2012). For example, Damascus, Syria's capital, suffered from the drying of its major spring in July 2001. Consequently, the capital was left with scarce and insufficient water resources to supply the demands of its population because water was flowing up to 4 hours per day (Eickelpasch, 2007). Between Syria and Israel, lies another tension at the Golan Heights where the river of Galilee passes. This river is not only affected by wars and bombs but also by global warming. With time the wildlife and fish species will be lost from this river.

[Israel](#), a parliamentary republic in the Middle East is 20,770- 22,072km² of which 2% is water. It is known for its scarcity in water which drove this country to implement technological innovation as a mean to economically and efficiently use water resources (drip irrigation) and to produce clean water. It is important to note that its geographical location and its demographic distribution play a crucial role in water source availability. Israel is so narrow that the "exclusive economic zone in the Mediterranean is double the land area of the country" (Grossman & Ofira,

2007). Springs remain the single largest water source for irrigation and a significant source for watering livestock in the area, with some also providing water for domestic consumption in areas not connected to pipelines. Furthermore, Israel by year 2007 was dried and its groundwater sources were completely exhausted, according to Dr. Majzoub. The Israeli government drilled and pumped water from a great depth which made the replenishment of the [underground water](#) difficult. Currently, Israel is facing severe water deficiency which drove the country to rely on surface water, the low amount of water coming from surrounding countries and from the desalination of sea water (Eickelpasch, 2007).

b. Predicted Global Climate Changes on the Eastern Mediterranean

The Eastern Mediterranean, just like all other areas of the globe, manifested an intense population growth which led to increased needs of water sources to meet the demands for survival. Water is the basic requirement to keep civilizations alive because it keeps lands fertile for agriculture, improves productivity and opens opportunities to export produced goods. The development and improvement of industrialization is another factor that affects global climate change. According to the report prepared by the [Cyprus Institute](#) on the regional climate assessment, they projected the global climate change's environmental impacts using a model based on intermediate emissions in this region. They predicted significantly dryer and warmer weather conditions. As scientists found, the global climate change will tend to increase the earth's temperature as the initial mechanism. Eventually, the earth's balance will be altered and the thermohaline circulation system (THC) will be disrupted leading to extremely colder temperature or mini ice age in Europe, warmer weather in Africa and a dryer but warmer temperature in the Middle East. The predicted increase in temperature in the Middle East will range on average by 1-3°C in the coming next 3 decades, 3-5°C by mid-century and 3.5-7°C by the end of this century. If we do the calculations, we will observe that approximately the temperature will rise by $0.37 \pm 0.9^\circ\text{C}$ per decade. According to the Cyprus Institute's report, the Eastern Mediterranean region will warm at a faster rate than that of the globe. The model also expected a decrease in the precipitation (rainfall and snowfall) by 20% as another mechanism of global climate change (The Cyprus Institute, 2011). The decline in rainfall will severely affect the region, especially if the country already exhausted its underground water reserves as in Israel. The latter's remaining water source will be from desalinating sea water which has several drawbacks as increased energy consumption, air pollution and cost. Another mechanism by

which climate change will affect the Eastern Mediterranean is via sea level rise. This rise will affect the coast of Lebanon and Israel, while Syria won't be affected (The Cyprus Institute, 2011).

3. Predicted Impacts

The previously mentioned mechanisms are the direct effects of global climate change. These mechanisms are the ones that will exert serious impacts both on the environment and on the human health especially from the increased heat stress and the decline in rainfall.

a. Environmental Impacts

Starting with the [environmental impacts](#), extreme events will occur in the region as it was described previously. The Eastern Mediterranean region will be hit by increased storms, evotranspiration and droughts. Not only these natural changes will severely occur, but also their frequency will be increased. The elevated hot temperature will increase the risk of forest fires, decreasing the ground cover and infiltration and increasing erosion. If we further considered the contribution of using underground water with all these factors, the end result will be diminishing the groundwater recharge (Khawlie, 2001).

At the level of the fresh water resources, the decreased rainfall will result in a river discharge decrease of 10-30% by the end of the 21st Century, according to the [Cyprus Institute's](#) report (The Cyprus Institute, 2011). Eventually, available freshwater will be reduced which will have noticeable agricultural implications. The reduction in surface and ground water quality due to higher temperatures will reduce dissolved oxygen levels and stream flow and lake levels. Therefore, pollutants will be less diluted increasing the risk of vector borne diseases and pathogens (Khawlie, 2001).

Global climate change will also have impacts on land and ecosystems. The Eastern Mediterranean is rich with its biodiversity knowing its large gradients in topography, its rich soil and its varied climate which allows seasonal crops (The Cyprus Institute, 2011). Obviously, the predicted [dry climate](#) will alter the balance of species, due to seasonal changes that will be incurred. For instance, the expected milder winters will be associated with a prolonged growing season while it will be counterbalanced by increased hot days and decreased soil moisture which will delay and could potentially kill the crops (Karam, 2002). Therefore, desertification and deforestation will be manifested as well.

In terms of the impacts on the marine biodiversity, it will be seriously affected mainly because of the disruption in the THC system balance. The water warming and the increasing salt content will result in water mass stabilization. Furthermore, the sea level rise is expected to reach nearly 1.3-2.5 cm per decade. Ultimately, according to the Cyprus Institute's report, the nutrients' availability will be diminished, and marine ecosystems will become more 'tropical' (The Cyprus Institute, 2011). Moreover, the rise in sea water will lead to salt water intrusion which will further aggravate the problems.

b. Human Health Impacts

The [human health impacts](#) provide public health practitioners the room to interfere in awareness campaigns and in setting possible intervention plans to minimize the impacts of the predicted problem. The sea water rise intrusion into the coaster aquifers, sewage and storm water sea outfalls in coastal areas will contribute to the worsening of the global climate change impacts. The previously mentioned climate changes via the temperature, precipitation, soil moisture and others will alter the crops and food yields contributing in malnutrition. Furthermore, the stress on the wildlife and marine ecosystems, the warming of air and sea ice retreats will lead to fishing subsistence (McMichael, Woodruff, & Hales, 2006).

Vector-borne parasitic and viral diseases are expected to increase in prevalence as an indirect impact of global climate change. Global warming plays a major role in spreading of vector-borne diseases via increased temperature (The Cyprus Institute, 2011). However, we should not forget that other factors play a role in the transmission of infections, whether related to the pathogen itself as growth, multiplication and invasion or to the humans or cattle's susceptibility and immunity. [Water borne infectious diseases](#) from floods and droughts are important manifestations that should not be ignored because in such natural disasters, transmission rates between inter and intra species become uncontrolled. For example, flooding may trigger outbreaks of diarrhea; low rainfall can promote the growth of mosquito-carrying infections and high temperature promotes Salmonellosis (McMichael, Woodruff, & Hales, 2006).

Regarding air pollution, it is already a known threat to people's health around the globe. For instance, developing countries as in the Eastern Mediterranean, do not abide by laws, if present, to minimize emissions of Sulfur Dioxide, Nitrogen Oxides, Carbon Dioxide and other greenhouse gases. What is important to mention is that these emissions constitute the major

component of the global climate change cycle. For instance, taking the case of Israel, they are currently relying on desalinating sea water. The desalination process requires energy and emits many toxic and greenhouse gases from the power plants. Hence, the end product will be increased drinking water, decreased sea water and increased air pollution which will aggravate the global warming. Therefore, we will find the Eastern Mediterranean in a viscous cycle where the exit from it is difficult and almost impossible. Megacities are abundant in the Eastern Mediterranean just like other parts of the world, therefore it is expected that the air quality will further diminish and the global warming problem will be aggravated with increased traffic and emissions from power plants (The Cyprus Institute, 2011).

When we discuss [air pollution](#) due to global climate change, we will have two major manifestations which deal with increased in aerosol fine particles and ozone smog. According to the Cyprus Institute's report on the global climate change impacts on the Eastern Mediterranean region, the levels of fine particles are expected to rise substantially during the mid-21st Century as the sulfur dioxide and nitrogen oxides emissions increase. Concerning the second manifestation, the original climate of the Eastern Mediterranean is cloud-free during the summer; hence the increased solar radiation promotes the ozone smog. Currently, the ozone levels exceed the air quality limits in summer in the studied region, the question remains, where are we heading in the Eastern Mediterranean? The populations including the susceptible subpopulations are prone to respiratory infections, cardiovascular diseases and cancers via oxidative stress when exposed to bad air quality (The Cyprus Institute, 2011). Moreover, dry weathers favor the multiplication of viruses and their transmission will be enhanced.

c. Political Impacts

The Litany River fully flows within the Lebanese borders; however, conflicts always ran around it between Lebanon and Israel. Israel conquered South Lebanon twice in 1978 and 1982. Rumors and speculations have always been discussed were some people thought that during these invasions Israel was able to either build a dam on this river or to covert its path into the Marjiyun heights in South Lebanon. Although not any proof exists about these speculations, but it has been known that the underlying reason to conquer Lebanon is its water richness. For instance, the subject rises and becomes the hottest topic on the news while at other times it disappears. However, water has always been the major predictor in "[politics, negotiations and military confrontations.](#)" (Eickelpasch, 2007).

It is crucial to mention that Lebanon which already stands under political and economic tensions, cannot afford further wars, if it was of a direct political reason or of an indirect impact of global climate change. On one hand, Lebanon's relation with Syria is the opposite of that with Israel. Lebanon signed the "[Treaty of Brotherhood](#)" in 1991 with Syria. Therefore, we could perceive that the previously described impacts of global climate change might lead to water refugees. As villages in Syria are drying, people will leave their villages looking for fertile lands. Eventually, in the coming years, we will see a massive flow of people from Syria to Lebanon under the condition that the Treaty of Brotherhood" is still viable. On the other hand, Lebanon's relation with Israel is tense and was engraved with blood. If Israel continues to use its available water inefficiently, war for water on Lebanon and on Jordan is expected (Eickelpasch, 2007).

4. Action Plan

Internationally, nation states have endeavored to forge diplomatic agreements to help humankind cope with both the causes and consequences of global climate change. If the Middle Eastern countries especially Israel, continue to tap into underground water aquifers at such unsustainable rates without replenishing the [underground water](#) and developing new means to produce water, we can predict that adverse impacts on water availability and quality will deteriorate even without climate change effects (Bou-Zeid & El-Fadel, 2002).

As previously mentioned, Lebanon is the richest among its relative countries in water resources, yet it won't be able to meet its own water demands by the year 2025. This totally contradicts with what was long-held view by politicians, historians and researchers that Lebanon is water rich and should share its water with its neighboring countries. Lebanon faced long difficult years of wars (1975-1990) which left its infrastructure and water resources damaged (Bou-Zeid & El-Fadel, 2002). According to the [general circulation model](#) (GCM), the annual net usable water resources in Lebanon will most probably decrease by 15% as the average temperature rises by 1.2°C under double CO₂ conditions as stated in the Intergovernmental Panel on Climate Change (IPCC) report (Cruz, 2007).

When looking for solutions for this global concern, we should keep in mind that it all begins with one individual, one nation, one country, one continent to reach the globe. From the public health perspective, there is so much to be done. Initially, we can provide relevant awareness to the community; counsel on the proper life-style and on adequate water usage. The governments

should set relevant and appropriate legislations and make sure to enforce them on the society to avoid wasting water. It could set taxes on [sea water desalinating](#) power plants and others to reduce their emissions. It should stimulate the companies to innovate water resources by giving them incentives to do so in terms of subsidies and in providing them with the required financial resources (Khawlie, 2001).

In this concern, there are no comprehensive [development plans](#) to adapt to the anticipated climate changes. The globe is already suffering from finding solutions for this issue. At the Eastern Mediterranean level, we can play a major role in minimizing the impacts of global climate change at three major levels. To do so, we should develop a water management strategy which is based on proper water demand management, storage and encourage the technological development to save water resources (Karam, 2002).

To ensure proper water demand management, we should reduce water wasting in agriculture by using sprinklers, drip irrigation methods and minimizing leaks. One new and important element is the concept of "virtual water". Growing wheat, for example, takes a lot of water. By importing wheat and concentrating on crops which require less water, a country can acquire ["virtual water"](#) and use existing resources more efficiently (An open door to the Arab world , 2012). Therefore, proper crop selection is crucial and growing rain fed crops will save a lot of water. In houses, illegal distribution networks should be reduced and water saving devices in homes should be established such as dual flush toilets, automated or timed water faucets, etc (Karam, 2002).

Water storage strategies can also be implemented by recharging groundwater from desalinated water, dams could be built especially in Lebanon, which has 17 rivers, and water could be stored in reservoirs.

Alternative water sources provide the best yet the most expensive solution. For example, water recycle is a process currently implemented in many areas around the world such as California and Belgium. The earth via a natural water cycle has recycled and reused water for millions of years. Based on the United States Environmental Protection Agency (US-EPA) definition; water recycling refers to projects that use technology to speed up these natural processes, to ensure enough water for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing, municipal wastewater or sewage and replenishing ground water (Water Recycling and Reuse: The Environmental Benefits, 2012).[Water recycling](#) is essential in

sustainability because it saves resources, fulfills most water demands and is associated with financial savings. Furthermore, sea water desalinization as is being done in Israel is their only and best way to provide water for their population. However, we should keep in mind, that desalinating power plants are further contributing to the air pollution and to global warming via their green gas emissions.

5. Conclusion

In conclusion, the world is currently living beyond the earth's capacity to absorb the waste products from both natural and anthropogenic greenhouse gases. It is crucial to keep in mind the susceptibility patterns of the environment and populations when dealing with global climate change. Continuous research should be further conducted to estimate the magnitude of the environmental and human health consequences of climate change. These estimations will be the key players in international debates and they will urge decisions and solutions to be undergone. Such research, once properly conducted, will help both the nations in general and the Eastern Mediterranean, in specific, to better understand the real meaning of sustainability (McMichael, Woodruff, & Hales, 2006). Sustainable development is becoming a far reached goal day after day with the increased global environmental problems that limit the needed radical changes. This led to the call for departure from the extensive economic growth towards sustainable [degrowth](#) that comprises a smaller economy with less production and consumption. We ask; how to enjoy a "good life", is it through degrowth? Sustainable development is defined as a socially sustainable process of downshifting the society's metabolism (Martinez-Alier & Pascaul, 2010). Will degrowth ensure better water source availability? If people properly and minimally used water, will the problem of climate change in the Eastern Mediterranean be solved without heading to further tensions and wars between Lebanon, Syria and Israel?

This issue is the major concern of the globe, with time, more research will be done and it will become more important as the nations' suffering becomes more obvious as in South Africa, Alaska and Northern Europe. I hope that it will be solved, yet this is far to be realized, especially with increased harmful technology as nuclear power. However, the Middle East especially Lebanon, will not be severely harmed from the global warming as other countries because of our geographical status; yet Lebanon will be prone to further political tensions and wars from its surrounding neighbors. Syria will dry with time as available water will be diminished and Israel will keep innovating its technology to desalinate sea water.

6. Bibliography

- An open door to the Arab world* . (2012, May). Retrieved June 24, 2012, from Al Bab: <http://www.al-bab.com/arab/env/water.htm>
- Syria: Geography, Weather, & Wildlife*. (2012, May). Retrieved June 25, 2012, from Safari the Globe: Travel Destinations, Guides, Pictures, & More: http://www.safaritheglobe.com/geography_syria.aspx
- Water Recycling and Reuse: The Environmental Benefits*. (2012). Retrieved June 25, 2012, from United States Environmental Protection Agency (EPA): <http://www.epa.gov/region9/water/recycling/>
- Bou-Zeid, E., & El-Fadel, M. (2002, September/ October). Climate Change and Water Resources in Lebanon and the Middle East. *JOURNAL OF WATER RESOURCES PLANNING AND MANAGEMENT*, pp. 343-355.
- Cruz, R. H. (2007). *Asia Climate Change: Impacts, Adaptation and Vulnerability*. Intergovernmental Panel on Climate Change. UK: Cambridge University Press.
- Eickelpasch, T. (2007, April 28). *Water as a Conflict Issue in South Lebanon*. Retrieved June 23, 2012, from The People's Voice : <http://www.thepeoplesvoice.org/cgi-bin/blogs/voices.php/2007/04/28/p16387>
- Emberling, G. (2010). *The Geography of the Middle East*. Retrieved June 23, 2012, from Teaching the Middle East: A resource for education: <http://teachmiddleeast.lib.uchicago.edu/foundations/geography/essay/essay-01.html>
- Grossman, G., & Ofira, A. (2007). *Solar energy for the production of heat Summary and recommendations of the 4th assembly of the energy forum at SNI*. The Samuel Neaman Institute for Advanced Research in Science and Technology.
- Karam, F. (2002). *Climate Change and Variability in Lebanon: Impact on Land Use Climate Change and Variability in Lebanon: Impact on Land Use*. Lebanese Agricultural Research.
- Khawlie, R. M. (2001). *The Impacts of Climate Change on Water Resources of Lebanon- Eastern Mediterranean*. Milano: National Centre for Remote Sensing.
- Martinez-Alier, O., & Pascaul, U. (2010). Sustainable De-Growth: Mapping the Context, Criticisms, and Future Prospects of an Emergent Paradigm. *Ecological Economics*, 1741-1747.
- McMichael, J. A., Woodruff, E. R., & Hales, S. (2006, March 7). Climate change and human health: present and future risks. *The Lancet* , pp. 859-869.
- The Cyprus Institute. (2011). *A Regional Climate Assessment by the Cyprus Institute*. Cyprus: Research Medial LTD.