## ABSTRACT

**TITLE OF THESIS:** Climate Change and the Management of Water Resources: Implications for Security and Intelligence in Europe and the United States

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The U.S. National Security and Intelligence Communities are beginning to understand the consequences posed by climate change and its implications for regional stability, but the communities do not seem to view the pending water crisis as an issue of concern. This thesis examines and compares three regions of the world that are facing water issues that will be impacted by climate change: The Middle East, North Africa, and Latin America, and what the implications are for the United States National Security interests. Water scarcity will become more severe in parts of the world as climate change causes precipitation patterns and levels to change, the world's population continues to grow, and if adequate measures are not taken to better manage the world's limited water supply. Millions of people are suffering water scarcity today, and projections are that these numbers will increase. All three regions show a problem that is continuing to get

worse, while a lack of cooperation between the nations in these areas is intensifying the problem.

The results of the thesis show that mismanagement of water resources is an underlying cause of the problems in most of the countries. The results further show the necessity for international treaties to govern shared water resources between nations. International organizations and funding are also needed to assist countries in better managing their limited water supplies. Latin America may have more potential for cooperation over water issues, than the other two regions, but with proper mediation, it may be possible to overcome partisan concerns, so that everyone in these regions receives an adequate supply of water. The data collected in this thesis gives the US Intelligence Community a better understanding of the water scarcity issues the Middle East, North Africa, and Latin America, as well as insight into avenues that may lead to conflict, if cooperation is not achieved.

endorsement of the opinions, ideas, or information put forth. The thesis is not finished intelligence or finished policy. The validity, reliability, and relevance of the information contained have not been reviewed through intelligence or policy procedures and processes. The thesis has been classified in accordance with community standards. The thesis, in whole or in part, is not cleared for public release

# CLIMATE CHANGE AND THE MANAGEMENT OF WATER RESOURCES: IMPLICATIONS FOR SECURITY AND INTELLIGENCE IN EUROPE & THE UNITED STATES

by

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The views expressed in this paper are those of the author and
do not reflect the official policy or position of the
Department of Defense or the U.S. Government

## DEDICATION

For my loving wife, (b) (6) for without her love and support, I could not succeed.

Special thanks to my thesis chair (b) (6) for the endless hours he spent reading and editing my work.

Special thanks to (b) (6) for being my thesis reader and taking the time to make sure I submitted a quality product.

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# CHAPTER 1

## WATER SCARCITY ISSUES IN THE MIDDLE EAST, NORTH AFRICA, AND LATIN AMERICA AND HOW CLIMATE CHANGE IS IMPACTING THE SITUATION

"These concerns are more than justified as recent estimates point out that by the year 2025 over 40% of the world's population could be living in water-scarce regions."[1]

-Monique Barbut,
Director, Division of Technology, Industry & Economics,
United Nations Environment Programme

The need for water is critical to all human beings, thus water security is critical to all nation states and international organizations. The quote above by the United Nations Environment Programme Finance Initiative refers to the concerns over the future challenges that all institutions face as water scarcity becomes more intense in certain regions of the world.[2] The United States is concerned with how water scarcity is affecting stability in nation states which are already fragile. As water becomes more scarce, the potential exists for conflict and migration as these populations depend on water for agriculture to support their basic needs.

Climate Change is being made worse by mankind's emissions of green house gases. Areas affected by drought like conditions are facing greater hardships, due to the mismanagement of fresh water resources. Pollution of fresh water adds to the challenge. The problem will only get worse in the foreseeable future, and as fresh water becomes scarcer, the possibility of conflict over water increases.

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[1] The United Nations Environment Programme Finance Initiative (UNEP FI). *Challenges of Water Scarcity*. Stockholm International Water Institute, Stockholm, 2005

[2] Ibid.

Climate Change occurs naturally, but in the past 100 years it appears to have been exacerbated by mankind. Studies have shown that the global warming trend will continue, unless steps are taken to reduce mankind's greenhouse emissions. One result of this trend is that the world's climate will become wetter or dryer, depending on the part of the world, due to rising temperatures. Warmer temperatures will lead to an increase in evaporation, and allow the atmosphere to hold water longer. Thus, rainfall will be less, but when it does occur, it will be more intense. This, in turn, will affect agricultural production, as there will be less soil moisture during critical periods of the growing season. This prediction is based on global meteorological circulation models and investigation done by the Konza Prarie Long Term Ecological Research stations, on the affect of altered rainfall patterns.[3] Data compiled since 1900 show that areas north of 30 degrees latitude have already experienced increased precipitation.[4]

Due to extreme drought conditions, some parts of the world may become unlivable. Some of the areas that may experience extreme drought conditions already have water issues, due to mismanagement of the water resources by most of the countries in these regions, as they do not have the expertise to properly manage the internal water resources. Corruption may occur and cause unequal distribution, while political constraints prevent them from working with their neighboring countries that they share water resources with. Fresh water resources are being mismanaged, both in the way they are distributed and how they are sanitized. Chapter 3 will show that Libya is spending

[3] David L. Hoover, Guiling L. Wang, and Zoe G. Cardon, "Altered Precipitation patterns due to climate change: Modeling the ecological effects on a tallgrass prarie ecosystem," eco.confex. com, http://eco.confex.com/eco/2008/techprogram/P12275.HTM, (accessed June 20, 2009)

[4] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030.* Washington, DC: GPO, 9

over $27 billion to pipe water over 600 miles, so residents along the coast can harvest wheat in a dry climate. Lebanon cannot conduct future water planning, since it does not know what its water resources are. Chapter 4 will highlight Brazil, which is building large hydroelectric dams along the Amazon River, but cannot provide electricity to its rural population. With limited water resources and worsening drought conditions, it is important that the distribution and maintenance of the fresh water in the affected regions which include parts of Africa, China, India, Australia, Mexico, northeast Brazil, the plains of Peru, the southwestern United States, and tropical Asia, is managed carefully.[5]

Areas, such as the Sahel region of Africa, are becoming more drought stricken, with limited fresh water resources, face economic hardships that will continue to worsen over time as the length of the growing season will shorten.[6] As the living conditions becomes worse, populations will migrate into more developed areas that may be better prepared to deal with climate change, but will face climate challenges of their own. As fresh water availability becomes scare in certain areas, countries may come into conflict with each other over this essential element. Water management in the affected regions will take expert planning as noted by Kevin Trenberth, head of climate analysis at the National Center for Atmospheric Research. Trenberth "expects water resources to be

[5] The Center for Naval Analysis. *National Security and the Threat of Climate Change*. The CNA Corporation. Alexandria, Va 2007, 20-34

[6] M.L. Parry, ed, et al. IPCC, 2007, Summary for Policymakers. In: Climate Change 2007: Impacts, Vulnerability. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* {Cambridge: University Press, 2007}, 9

'one of the big pressure points on societies'. So water managers, for example, will have to find ways to save water in times of plenty for use in times of drought."[7]

In their study, "National Security and the Threat of Climate Change," The Center for Naval Analysis states: "Climate change can act as a threat multiplier for instability in some of the most volatile regions of the world, and presents significant national security challenges for the United States."[8] The Intelligence Community (IC) must be concerned with how water is managed in those areas where conditions may be made worse by climate change. To better analyze these issues, the IC will need to work with organizations such as the Intergovernmental Panel on Climate Change (IPCC) and the Center for International Earth Science Information Network (CIESIN).[9] Conflicts have occurred over water in the past, and will continue in the future, unless mankind learns to manage its most critical resource. This is because water is mankind's most precious resource. If a group can eliminate their adversary's access to water, they will gain a tactical advantage. Examples go back to 689 B.C., when Sennacherib of Assyria attacked Babylon, destroyed the irrigation system, and diverted water to flood the city. More recently, the Israeli diversion of the waters of the Jordan River triggered the Arab-Israeli War in 1967.[10]

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[7] Miguel Lianos, "Time for drastic action against warming: Report that says warming to last for 1,000 years could create momentum," MSNBC News, entry posted January 28, 2009, http://www.msnbc.msn.com /id/28874983/ (accessed January 28, 2009)

[8] The Center for Naval Analysis. *National Security and the Threat of Climate Change*. 44

[9] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030*, 39-40

[10] Michael T. Klare, *Resource Wars: The New Landscape of Global Conflict*. New York: Henry Holt and Company, LLC. 2002, 138-9

## THE TOPIC

The National Intelligence Council is concerned about global migratory trends that affect regional stability, and which are associated with climate change. The National Intelligence Council (NIC) projects that by 2015, one half of the world's population will live in water stressed countries.[11] "By 2025, forty-eight percent of the world's population will be in countries experiencing significant water shortages,"[12] while twenty nations in the Middle East and Africa will be considered critical. The study by the Center for Naval Analysis lists Turkey, Syria, and Egypt as three of the top ten countries facing water related stability issues. The Jordan-Litani system, the Nile System, and The Tigris-Euphrates, along with Libyan use of the sub-Saharan aquifer, are listed as some of the potential "hot spots" for conflict over water.[13] The NIC also observes three factors that could impact on regional security: changes in water availability, changes in agriculture productivity, and damages to economically significant infrastructure.[14] Based on the recent National Intelligence Assessment conducted on Global Climate Change, the NIC has major concerns about the world's freshwater supply, as well as other climate issues.[15]

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[11] The National Intelligence Council, "Global Trends 2015", entry posted December 2000, http://www.dni.gov/nic/PDF_GIF_global/globaltrend2015.pdf, (accessed May 18, 2009), 27

[12] The Center for Naval Analysis. *National Security and the Threat of Climate Change*. The CNA Corporation. Alexandria, Va 2007, 16

[13] Ibid., 15-16, 30,

[14] Richard Engel MG(R), *Climate Change: Impact on National Security*. National Intelligence Council. 2008, 21

[15] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030.* 1-58

This thesis will focus on three geographic regions of particular concern: North Africa, The Middle East, and Latin America, and how climate change is impacting the water resources in those three regions. Estimates by the Center for Naval Analysis (2007) and the National Intelligence Analysis on Climate Change (2008) expect all of these regions to be affected by climate change and changes in their water resources.[16] The intent of this thesis is to examine all three regions, to learn where potential regional conflicts may arise, and how they may be mitigated. The thesis examines what may trigger migration out of the affected areas, and what the economic and security implications for the United States and Europe may be, due to both regional instability and a possible rapid increase of migration. The goal is to identify similarities and differences between each region, how each may be affected by the scarcity of fresh water, and how climate change is impacting the water scarcity. The underlying question of this examination is what can and should the United States and Europe do to help the affected countries and their populations, before the situation becomes critical?

**The Middle East, North Africa and Latin America**

The regions of North Africa, the Middle East and Latin America have been chosen because each region has governments who are not doing the proper planning and research to mitigate this problem. This is based on the continued disputes in the Middle East along the Jordan, Tigris, and Euphrates Rivers, which have prevented proper water conservation planning in both Lebanon in North Africa and Ecuador in Latin America**.** The governments do not have an accurate analysis of how much water they do have, so

[16] The Center for Naval Analysis. *National Security and the Threat of Climate Change*. 15, 20-22, 30-34

they are unable to implement a proper management plan. All three regions have countries that suffer economic hardships, which are made worse by the climates they live in. Based on 2008 statistics 45% of Yemen's population and 47% of Venezuela's population live below the poverty line.[17] Examples will be shown of Venezuela's coastal population dealing with water pollution and an increase in water salinity, and Yemen overpumping its water resources. Both show how a country's climate can affect current and future economic prosperity. All three regions have countries with difficulties managing the fresh water resources they do have**.** This is due to several factors: lack of education concerning modern management techniques such as drip irrigation; not understanding how much water is in the surface and underground reservoirs; overpumping the limited water supplies; and overuse due to the demands of growing populations. The areas being studied all risk the potential for conflict over water, and the potential for population shifts due to the lack of water.[18]

Although at first glance, one may think that rising sea levels have nothing to do with fresh water resources, populations along coastal regions may disagree in the future. The United States is not immune to this, as researchers believe that the Northeast will experience an increase in frequency and intensity of flooding due to sea level rise.[19] Saltwater from rising sea levels will seep into freshwater aquifers along with topsoil for agriculture. This scenario could lead to population shifts and/or an increased need for

[17] CIA World Fact Book, "Economy Statistics > Population below the poverty line (most recent) by country," NationMaster.com, http://www.nationmaster.com/graph/eco_pop_bel_pov_lin-economy-population-below-poverty-line, (accessed June 20,2009)

[18] This conclusion is based on the 2008 National Intelligence Analysis on Climate Change.

[19] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030,* 16

desalination plants. In the developing world, these populations will require international assistance. Researchers believe that the most significant impacts will occur in the Central America and Mediterranean regions.[20]

According to David Seckler from the International Water Management Institute,

> Many of the most populous countries in the world-China, India, Pakistan, Mexico, and nearly all the countries of the Middle East and North Africa have literally been having a free ride over the past two or three decades by depleting their ground water resources. The penalty for mismanaging this valuable resource is now coming due and it is no exaggeration to say that the results could be catastrophic for these countries and given their importance, for the world as a whole.[21]

While reviewing sources, such as the 2008 National Intelligence Assessment on Climate Change, the 2007 Center for Naval Analysis study on Climate Change and Kurt M. Campbell's Climatic Cataclysm,[22] most agree that these three regions will incur changing precipitation levels and reduced fresh water availability, which may lead to population shifts to the developed world or conflict within or between countries. The 2008 National Intelligence Assessment on Climate Change poses the question: "What is the most likely response to environmental stress: "flight" (immigration) or "fight" (armed conflict)?"[23] If the Muslim populations of North Africa and the Middle East become "eco-immigrants" and strive to immigrate to the European Union, would the European

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[20] Kurt M.Campbell, ed. *Climatic Cataclysm: The Foreign Policy and National Security Implications of Climate Change*, Washington D.C.: Brookings Institution Press, 2008, 66

[21] David Seckler, International Water Management Institute, quoted in Brown, Lester R., *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble*, New York: W.W. Norton & Company, 2006, 57-58

[22] All three of these sources derive their information scientific data that has been collected and analyzed by the IPCC (Intergovernmental Panel on Climate Change) which was formed in 1988 by the World Meteorological Organization and the United Nations Environment Programme.

[23] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030*. 5-6

Union further wall off their borders, either through physical barriers, ship blockades, or deportation? This scenario would create further resentment against Europe from Muslim populations in the developing world that already feel isolated. The same issues will occur if a desperate Latin American population were to attempt to migrate to the United States, due to a projected increase in droughts and water scarcity in Mexico, Central America, and portions of Brazil and Peru.[24]

Further alarm is raised when one looks at some of the current environmental assessments for these regions. Some of the smallest amounts of arable land exist in the Middle East and North Africa. Approximately 1.1 billion people worldwide lack access to potable water. This number includes 1/5 of the Middle East population and 1/5 of the population of Latin America. During the period of 1975-2001, the largest number of droughts occurred in Africa, with Latin America as the third highest region; with climate change worsening, droughts for these regions are expected to increase in duration and magnitude. Latin America and Africa are the second and third leading regions, with the largest number of floods during the same time periods. These problems will only be made worse, as Africa and Latin America are leading regions for deforestation.[25]

The increase in regional droughts and floods is due to an increase in the mean global temperature by .74C over a 100 year period (1906-2005).[26] Scientists have observed that the amount of $CO_2$ in the atmosphere has increased by 35% in the industrial

[24] Campbell ed. *Climatic Cataclysm,* 99-105, Predictions are based on scientific studies collected by the IPCC that have observed regional climate change, past glacial cycles, and past abrupt climate changes to predict 21st century climate change.

[25] Ragnhild Nordas, and Nils Peter Gleditsch, eds. *Climate Change and Conflict*, Political Geography, New York: Elsevier Publishers, August 2007, 627-694

[26] Intergovernmental Panel on Climate Change, "Climate Change 2007: Synthesis Report," IPCC, http://www.ipcc.ch/ipccreports/ar4-syr.htm, (accessed June 21, 2009)

era, and believe that it is very likely that human activities are the cause for the $CO_2$ increase, which in turn has brought about the temperature rise. $CO_2$ is a greenhouse gas, and along with water vapor acts as a blanket for radiation coming from the earth's surface to warm the planet.[27] Industrial nations bear the primary responsibility for the $CO_2$ increase, due to their carbon emissions; but based on the changing precipitations patterns, it is the developing nations that will feel the effects and will need to adapt. The United States and Europe are expected to experience moderate to significant exposure to climate change, compared to most of the rest of the world which will experience serious to extreme exposure.[28] Excluding Libya, South Africa, the Seychelles and Nigeria, each African country emits only .5 tons of $CO_2$ a year, compared to 20 tons from the United States alone.[29] The United States bears a moral responsibility to assist the developing world as the U.S. has been a major contributor to the changing climate.

It may be hard to envision a country such as Columbia having water issues, since Columbia is ranked seventh in the world in freshwater resources.[30] Unfortunately, due to poor management 38% of Columbians have little or no access to clean water, and that number could rise to 69% by 2025.[31] With almost 70% of the population suffering from water scarcity, it is conceivable that those citizens could migrate to the United States, or internal conflict could erupt as the citizens would be unsatisfied with the Columbian

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[27] Ibid.

[28] International Alert, *A Climate of Conflict: The links between climate change, peace, and war*, Dan Smith and Janani Vivekananda, {London, 2007} 18-19. Based on IPCC findings /projections.

[29] Ibid., 28. Based on 2007 UN statistics.

[30] Patty Jo. Sawvel, ed. *Water Resource Management: Introducing Issues with Opposing Viewpoints*, Farmington Hills: Green Haven Press, 2008, 46

[31] Ibid., 45-47

government's efforts to meet their basic needs. Compared to the United States, Columbia pays five to six times as much for clean water. With part of its border along the ocean, Columbia will feel the impact of strong storms and rising sea levels as it faces the effects of climate change.[32] Internal conflict could occur as coastal residents are forced to migrate inland, and may become squatters on private land.

For some countries in the Middle East, the water issue is worse than many people believe as evidenced by the 2008 drought in Syria, which forced the country to import more rice and wheat, along with Lebanon and Pakistan, which are forced to buy bottled water. Recent research suggests that by 2030, the Middle East and North Africa region will have to allocate 58% of its water resources to irrigation.[33] This is based on continued population growth, as the region's population is expected to increase by as much as 1.9 million in 2050, and will need more food to sustain itself.[34] By 2030, researchers expect regions such as South Asia and the Middle East to compete with each other to gain deals with water rich countries for agriculture products. A country has to import food when the available water per person drops below 1500 cubic meters.[35] Changing global diets that require more meat, require more water as livestock require grain for food, which needs water to grow. National Geographic reporter Joel K. Bourne Jr. notes**:** "It takes up to five times more grain to get the equivalent amount of calories

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[32] Ibid., 48

[33] Dominic Waughray, "The Pending Scramble for Water" BBC News, entry posted February 2, 2009, http://news.bbc.co.uk/2/hi/business/7790711.stm (accessed February 5, 2009)

[34] Farzaneh (Nazy) Roudi, "Population Trends and Challenges in the Middle East and North Africa," Population Reference Bureau, http://www.prb.org/Publications/ PolicyBriefs /PopulationTrends andChallengesintheMiddleEastandNorthAfrica.aspx, (accessed June 21, 2009)

[35] Dominic Waughray, "The Pending Scramble for Water" BBC News, entry posted February 2, 2009, http://news.bbc.co.uk/2/hi/business/7790711.stm (accessed February 5, 2009)

from eating pork as from simply eating grain itself, ten times if we're talking about grain-fattened U.S. beef."[36] Another problem is that three of the top ten food exporters are from water scarce regions, and three of the top ten importers are from water rich regions.[37] International regulations may be needed to ensure food products are grown in the right regions, so less water is wasted.[38]

## JUSTIFICATION

There are security implications for the United States and Europe, due to the potential for wars involving conflict over water in the Middle East, North Africa and Latin America. Lessons can be learned when studying and comparing these regions, in order to mitigate the problem. At present, the Director for the Climate Change and State Stability Program Office of the Director of National Intelligence is conducting long range analysis on six countries/regions: Russia, China, India, Mexico/Caribbean, North Africa, Southeast Asia/Pacific Islands, to determine if anticipated changes from the effects of climate change will force inter- and intra-state migrations, cause economic hardship, or result in increased social tensions (state stability).[39] The Director of National Intelligence is concerned about the possible negative consequences of global climate change, and its

[36] Joel K. Bourne Jr., "The End of Plenty, Special Report: The Global Food Crisis." *National Geographic*, June 2009, 41

[37] Dominic Waughray, "The Pending Scramble for Water" BBC News, entry posted February 2, 2009, http://news.bbc.co.uk/2/hi/business/7790711.stm (accessed February 5, 2009)

[38] Ibid.

[39] Richard Engel MG(R), Climate Change and State Stability Research Portfolio, National Intelligence Council. 2008

implications for the U.S. National Security. The 2008 National Intelligence Assessment on Climate Change states that: "adverse climate change impacts may originate within a country's national borders or spill in from unstable adjacent areas."[40] Thus, problems within a single country have the potential to have regional and even global consequences.

## THE RESEARCH QUESTION

The question this thesis seeks to examine is: What are the security and intelligence implications for the United States and its allies due to climate change and its affect on water resources, specifically in Latin America, North Africa and the Middle East? The emphasis of the research will be on how a lack water security, to include international treaties, decreasing water supplies, and mismanagement of water resources, may lead to state instability which is a cause for concern for the United States Intelligence Community. Research will look at specific countries in the three regions, their water resources, the water issues, (both internal and external), and how climate change may be impacting these issues.

[40] The National Intelligence Council. National Intelligence Analysis. National Security Implications of Global Climate Change to 2030, 1

## KEY QUESTIONS

To help answer the research question the following key questions will be addressed:

What is the current status of the water resources in these regions? The Middle East has to import a large portion of its fresh water. What is the status of the region(s) where it imports its fresh water from? In parts of South America that contain tropical rain forests and an abundance of precipitation, why is fresh water still an issue? Understanding the policies the governments have, or do not have, on the fresh water resources is critical. What effect do the growing populations in all three regions have on the limited water resources, and when will the population growth exceed the supply of fresh water in the regions? Finally, this research will explore how pollution is affecting the fresh water in these regions, and the health of the current water supply.

What is the impact of climate change on the water supply and the other natural resources in these regions? Scientists are predicting a rise in the earth's temperature, which will cause increased precipitation in certain regions, and increased droughts in others. How will climate change impact the fresh water supply? What effects will rising sea levels have on the fresh water resources?

Based on the previous questions, will populations in these regions be forced to migrate because of the worsening situation with regard to fresh water? The challenge when asking the migration question is to determine whether the migration is caused due to a lack of water resources, or is it because of other factors? Is the water supply a

contributing factor to other economic issues, which in turn contribute to the heightened possibility of migration?

Finally, what are the key triggers that may lead to conflict over water in these three regions? This research will examine the current treaties that are in place between neighboring countries, and what may lead these treaties to fail. Understanding what can and should be done to resolve these issues before they become critical, is key to addressing the problem.

## METHOD

### Research Design

This thesis involves a qualitative study, using multiple collection methods. The research examines all literature sources that concern climate change, water resources, the three regions being studied, and future predictions concerning how climate change and water issues will affect those regions. Interviews were conducted with (b) (6) the Director of National Intelligence, Center for Naval Analysis; (b) (6) and (b) (6) , environmental science professors from the National Defense University; and (b) (6) , an environmental science professor from the Army War College. The World Wildlife Federation, the Worldwatch Institute, the Center for International Earth Science Information Network (CIESIN) and the Intergovernmental Panel on Climate Change (IPCC) were also good sources for information.

### Data Collection Strategy

Data collection focused on current sources, books, journals, articles, interviews and reports. An effort was made to conduct interviews with experts in the field of climate change and fresh water management, especially those that have expertise in the regions that are being studied, both in the government and private sector. Data was collected on the fresh water resource conditions in the three regions, based on populations, water borne disease, sanitation regulations and regional treaties. Data was also collected on how climate change is affecting precipitation and temperature changes in the regions. Information on the economic conditions of the regions, and how this is related to climate change and water issues, was also examined.

### Analytical Strategy

The thesis uses comparative case studies to examine climate change and water management in each of the regions. The study analyzes the potential for conflict over water resources in each region, and the potential for increased migration due to the environmental conditions causing “climate migrants”. The study looks at each region, to understand what can be done to meet the challenges faced by climate change, and its impact on fresh water resources in all three regions.

## DEFINITIONS

The following definitions will be used throughout this thesis:

**Aquifer** is "an underground layer of rock which holds fresh water and allows water to percolate through it."[41] There are two types of aquifers, replenishable and nonreplenishable.

**Climate Change** is defined as "any long-term significant change in the "average weather" experienced, caused by dynamic processes on Earth, external forces including variations in sunlight intensity, and more recently by human activities. In recent usage, especially in the context of environmental policy, the term "climate change" often refers to changes in modern climate."[42]

**Desalination** refers to any of several processes that remove excess salt and other minerals from water. The World Wildlife Federation further defines it as "the processing of seawater habitat."[43]

**Desertification** occurs from land mismanagement or climate change where the land becomes increasingly arid and vegetation is replaced by arid species.[44]

**Global Warming** is the gradual increase of the temperature of the earth's lower atmosphere as a result of the increase in greenhouse gases since the Industrial Revolution.

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[41] Yara Corporation, "Resource Glossary," entry posted 2007, http://citizenship.yara.com /en/resources /glossary/index.html, (accessed May 24, 2009)

[42] Ibid.

[43] Patty Jo. Sawvel, ed. *Water Resource Management: Introducing Issues with Opposing Viewpoints*, Farmington Hills: Green Haven Press, 2008, 7-9

[44] United States National Park Service, "Glossary of Terms in Ecology and Restoration," entry posted 2004, http://www.nps.gov/plants/restore/library/glossary.htm, (accessed May 24, 2009)

**Latin America** is comprised of all countries south of the United States. These countries include: Argentina, Aruba, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, the Dominican Republic, Ecuador, El Salvador, French Guiana, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Martinique, Mexico, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Martin, Saint Pierre and Miquelon, Uruguay, and Venezuela. Central America is considered part of Latin America, and is comprised of Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama.

**Map 1-1 Latin America**

[45]

[45] University of Minnesota, "Latin American Studies," entry updated November 12, 2007, http://www.morris.umn.edu /academic /laas/images/LatinAmericaMap.jpg (accessed March 7, 2009)

**North Africa** is composed of the countries of Algeria, Egypt, Libya, Morocco, Sudan, Tunisia and Western Sahara.

**Map 1-2 North Africa**

[46]

**Non Replenishable (or fossil) Aquifers** are aquifers that once depleted pumping comes to an end.[47]

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[46] My Travel Guide, "North Africa Map," entry posted 2005, http://www.mytravelguide.com/g/maps/North-Africa-map.gif, (accessed March 7, 2009)

**The Middle East** is composed of Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Omar, the Palestine territories (Gaza and the West Bank), Qatar, Saudi Arabia, Syria, Turkey, the United Arab Emirates and Yemen.

**Map 1-3 The Middle East**

[48]

**Replenishable Aquifers** are aquifers that when they are depleted the maximum rate of pumping is automatically reduced to the rate of recharge.[49]

**Virtual Water**- "the quantity of water required for essential food imports needed by an economy"[50]

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[47] Lester R. Brown, *Plan B 2.0: Updated and Expanded, Rescuing a Planet Under Stress and a Civilization in Trouble.* New York: W.W. Norton & Company, 2006, 42-43

[48] Perry-Castañeda Library Map Collection, the University of Texas, " The Middle East," entry posted 2003, http://www.lib.utexas.edu/maps/middle_east_and_asia/middle_east_pol_2003.jpg (accessed May 24, 2009)

[49] Brown, *Plan B 2.0,* 42-43

[50] Abiodun, Alao *Natural Resources and Conflict in Africa: The Tragedy of Endowment*, Rochester: University of Rochester Press, 2007, 209

**Water Management-** is the practice of planning, developing, distribution and optimum utilizing of water resources under defined water polices and regulations. There is a need to consider multiple viewpoints, as there is competition for water along with complex institutional constraints.[51]

**Water Security-** is defined as "ensuring that every person has reliable access to enough safe water at an affordable price to lead a healthy, dignified and productive life, while maintaining the ecological systems that provide water and also depend on water."[52]

## ASSUMPTIONS

The main assumption of this study is that conditions in all three regions are going to get worse due to the continued poor management of fresh water resources, that conflicts may occur between countries over water resources, and that mass migrations due to water shortages may occur either as a result of these conditions. A current belief is that due to the ongoing war on terrorism and the current economic crisis, issues such as climate change and regional water issues that affect populations outside of the United States, will be a low priority for national security analysis for the near future. This thesis assumes that these issues still have the potential to have serious consequences for the United States national security, and thus must be addressed.

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[51] Neil S. Grigg, "Integrated Water Resources Management," Water Encyclopedia, entry posted 1996, http://www.waterencyclopedia.com/Hy-La/Integrated-Water-Resources-Management.html, (accessed May 24, 2009)

[52] Sawvel, *Water Resource Management,* 35

Another assumption is that extreme weather conditions will continue to occur and have adverse affects on agriculture. North Africa may also suffer due to drought conditions. A quote from the 2008 National Intelligence Assessment states: "Climate change probably will cause agricultural losses of up to 50 percent for some rain fed grain crops in some North African countries."[53] An assumption from this quote is that the agricultural losses have the potential to lead to migration and instability. A final assumption is that climate change is valid and is having and will continue to have an effect on mankind.

## THESIS/CHAPTER ORGANIZATION

Chapter 2 provides an overview of the existing situation in these regions. It will outline the basics of climate change and water management. It will provide an understanding of the history of Climate Change, and how water is managed or mismanaged in various regions of the world. It will further discuss why the United States should be concerned.

Chapter 3 focuses on North Africa and the Middle East. It examines how water is managed in these two regions. This chapter also explores the water treaties that exist between countries and the effect climate change will have on the water resources in these two regions. Chapter 3 also examines the possibility that climate change and a lack of

[53] Richard Engel MG(R), *Climate Change: Impact on National Security*. National Intelligence Council. 2008, 14

fresh water resources will cause population migrants, and will look at the economic and security issues based on instability brought about by conflicts over water.[54]

Chapter 4 will focus on Latin America. This chapter will look at the same issues as Chapter 3, such as how water is managed and in some cases mismanaged. The availability of the fresh water resources and how climate change is impacting them will be explored. The affect that climate change will have on the water resources in this region will be explored, as well as the potential for migration and economic security issues.

Chapter 5 will compare and contrast the issues in all three regions. It will identify the similarities and differences between the three regions, and the possible lessons that can be learned from the experiences of each region. What steps can and or should an organization such as the United Nations take to resolve these issues before they lead to a humanitarian crisis or a violent regional conflict? This chapter will summarize the data that has been collected and draw conclusions and recommendations for further research.

## CLASSIFICATION

The majority of the research for this thesis is unclassified. Most of the data in this thesis can be obtained through open source publications. Issues concerning regional, religious, and cultural practices may be sensitive in nature.

[54] The National Intelligence Council. National Intelligence Analysis. National Security Implications of Global Climate Change to 2030., 15, 21

## SOURCES

Information and insights concerning the latest findings and analysis were derived through interviews with experts in the fields of water management and climate change, along with researchers who have studied all three regions, especially those in the intelligence community. Interviews were also conducted with journalists and authors that have written about these issues.

Data collected by various government and environmental groups such as the National Oceanic Atmospheric Administration and the World Wildlife Federation were invaluable. The initial idea for the thesis came from reviewing studies by the National Intelligence Council and the Center for Naval Analysis. Constantly staying on top of the latest reports and findings was critical.

The information gathered from the interview on 28 February with (b) (6) from the Environmental College at the National Defense University was worthwhile. (b) (6) were able to recommend various websites such as the ones belonging to the World Bank, the Global and Environmental Outlook, the Pacific Institute, the Organization of American States, the World Watch Institute, and the United Nations Environment Program (UNEP). They also recommended various experts in the field of water issues such as Ken Conca from the University of Maryland, and Thomas Homer-Dixon, a leading environmental researcher from Canada. (b) (6) also provided recommendations on where to focus this thesis, in terms of the regions being studied.

The interview on 13 March with (b) (6) at the Army War College was also valuable. (b) (6) provided recommendations on areas to focus and additional research material to use for this thesis. He emphasized linking environmental security to US national security, and his input was used for the first five pages of Chapter 2.

## LITERATURE REVIEW

The National Intelligence Council's 2008 National Intelligence Assessment (NIA): *National Security Implications of Global Climate Change to 2030* [55] was the initial building block for the thesis. It provided useful information concerning the regions being studied, and the affect on the United States. It provided up to date information and future projections out to 2030. The NIA used studies such as one by Dr. Gober called: Climate Change, Migration and US National Security, and a study by Dr. Peter H. Gleick called Climate Change and Fresh Water Resources, along with references to important research institutes. "Projecting forward to 2030, the climate NIA speculates on everything from conflicts over scarce water and food, to huge refugee problems that might require U.S. forces to intervene in "extensive and novel" ways."[56] This assessment shows that in the age of globalization the United States and Europe cannot wall themselves off from everyone else's problems. The United States depends on other countries for imports. Even imports, such as cotton shirts, may not be available or become more costly due to the challenges of growing cotton in water scarce regions. The

[55] The National Intelligence Council. National Intelligence Analysis. National Security Implications of Global Climate Change to 2030. 1- 58

[56] John Wihbey, "Covering Climate Change As a National Security Issue," Yale Climate Media Forum, entry posted July 17th 2008, http://www.yaleclimatemediaforum.org/2008/07/covering-climate-change-as-a-national-security-issue/ (Accessed January 28, 2009)

refugee problems will further burden an already overtaxed U.S. military. The relevancy of this observation is that rising prices of imports, due to climate change, will affect the economic security of the United States.

The Center for Naval Analysis's 2007 study: *National Security and the Threat of Climate Change*[57] addresses three critical questions: what conditions are climate changes likely to produce around the world that would represent security risks to the United States? What are the ways in which these conditions may affect America's national security interests? And what actions should the nation take to address the national security consequences of climate change? The study provides input from retired Generals and Admirals of what the consequences of climate change could mean for various regions of the world, operational challenges, terrorism, and military research associated with the environment. The input from the retired Generals and Admirals is important, as many of them were regional Combatant Commanders, and provided insight into the security challenges in their regions. The report also provides predictions on how climate change will affect various regions of the world. It focuses on how well regions are prepared to deal with climate change, and which ones may be affected by issues such as extreme climate changes, migration, scarce water and conflict. The report lists its finding and recommendations, and discusses how issues such as national security, dependence on foreign oil and climate change are related. From this report, it is possible

[57] The Center for Naval Analysis. *National Security and the Threat of Climate Change*. The CNA Corporation. Alexandria, Va 2007

to better understand the long term security and stability consequences posed by climate change.

Diane Raines Ward's "Water Wars: Drought, Flood, Folly, and the Politics of Thirst"[58] provided a good overview of the global water crisis, along with an insightful historical overview. It discusses the history and current issues concerning water in countries such as Holland, Egypt, India, Iraq, Israel and the United States. Similar to other writers on water issues, she emphasizes the need for international water sharing agreements and how population growth along with a lack of oversight is depleting water resources in certain regions of the world. Ward discusses how climate change is changing global water resources with warmer temperatures leading to more droughts, changing precipitation, and less moisture in the soil in certain regions. "Water Wars" was an important asset when researching material for this study, as it provided information on the history of water conflicts in the Middle East and North Africa, and the current status of water in the countries being studied. Ward's opinions and insights on the effect of population growth and lack of water treaties enabled a better understanding of the potential for conflict and instability.

Lester R. Brown's "Plan B 2.0: Updated and Expanded, Rescuing a Planet Under Stress and a Civilization in Trouble"[59] was a good source concerning water issues. Most of the water issues were contained in Chapter 3. Chapter 3 also dealt with how food scarcity was important as water issues lead to agriculture issues. Mr. Brown did a good

[58] Diane Raines Ward, *Water Wars: Drought, Flood, Folly, and the Politics of Thirst*. New York: Riverhead Books, 2002, 1-307

[59] Brown, *Plan B 2.0,* 1-365

job of breaking Chapter 3 down into issues with falling water tables, rivers running dry, lakes disappearing, water issues concerning agriculture and national border issues. Throughout the chapter Mr. Brown gave specific examples of the issues in different regions of the world.

Kurt M. Campbell's "Climatic Cataclysm: The Foreign Policy and National Security Implications of Climate Change"[60] was an up to date source (early 2008) on the current and projected issues associated with climate change. The authors were experts in the national security area from agencies such as the Center for a New American Security and the Center for Strategic and International Studies such as Peter Ogden and John Podesta. Other writers included Leon Fuerth (former national security advisor to Vice President Al Gore), James Woolsey (former CIA director) and Jay Gulledge from the Pew Center on Global Climate Change. The book did a thorough job of discussing three different scenarios for climate change (expected, severe, and catastrophic) and what the implications could be. Campbell dedicated an entire chapter to each scenario, and the impact each would have on region of the world, as well as critical natural resources such as natural gas, oil, coal, nuclear power, along and opportunities for the international community.

Chapters 6 & 7 in Michael T. Klare's "Resource Wars: The New Landscape of Global Conflict"[61] were very critical to the research as they provided valuable insight into the water resources conflicts in the Nile, Jordan, and Tigris-Euphrates river basins. Klare

[60] Campbell, *Climatic Cataclysm,* 1-237

[61] Michael T. Klare, *Resource Wars: The New Landscape of Global Conflict*. New York: Henry Holt and Company, LLC. 2002, 1-289

emphasizes the potential for conflict in all three river basins. A comprehensive history of the cultures that depend on the river basins is given, previous conflicts over the basins are discussed, and how overuse from population growth and agriculture has affected the river basins. Information is given on how one country's plans for the river basin affects the other countries that depend on river and why international water sharing agreements are long overdue. The relevancy toward this study is that by gaining a better understanding of the potential for conflict in the three river basins, one gain better understanding the implications for the U.S. Intelligence Community as this region is critical to the United States.

Up to date reports on climate change and fresh water issues were critical. An October 7th 2008 study by the Wildlife Conservation looks at 12 disease carrying pathogens that could spread into new regions because of climate change, such as Ebola and Lyme disease. The spread of diseases, such as cholera which exists in small organisms in contaminated water at warm temperatures (which may be brought out by climate change), add to the climate induced issues which may contribute to instability in certain regions.[62] One report by the World Water Council, titled "Water Problems in Latin America," was published at the World Water Forum in 2006. This report on Latin America showed that 77 million people lack access to safe water, 100 million lack access to sanitation, and concerns over water pricing inequalities between the rich and poor.[63]

[62] Steven Sautner, "Deadly dozen reports diseases worsened by climate change," World Conservation Society, entry posted October 7, 2008, http://www.sciencedaily.com/releases /2008 /10/081007073928.htm, (accessed March 7, 2009)

[63] World Water Council, "Water Problems in Latin America," entry posted March 22, 2004, http://www.worldwatercouncil.org/fileadmin/wwc/News/WWC_News/water_problems_22.03.04.pdf, (accessed March 8, 2009)

The report also gave an overview of the issues concerning ground aquifers, rivers and national border issues.

## IMPLICATIONS FOR US NATIONAL INTERESTS

The Intelligence Community needs to be concerned about how water is managed in those areas whose arid climates are made worse by climate change as the potential exists for internal conflict and migrations. Migration shifts may occur from Mexico and the Caribbean into the United States, and from North Africa and the Middle East into Europe**.** The United States and Europe are not expected to face the same level of water scarcity and climatic events as the nations in these regions. Just like NGOs, USAID works with developing countries on managing their resources, there is a need for the governments of the developed world to work with the governments of the developing world to establish better water management techniques, realistic water expectations, and possibly population controls for certain regions. The governments of the developed world may be unable to assist parts of the developing world with better water management, as the governments there may not want help, and are only concerned that the rich receive access to an adequate amount of water (examples will be shown of Bolivia and Columbia). The challenge is that water issues seem to become a lower priority, whenever another crisis occurs. Despite these obstacles, the United States should use international water issues as a foreign policy tool, since unequal water distributed between neighboring countries, has the potential to lead to conflict and instability. In such cases, the United States could act as a mediator between countries to

resolve issues.[64] Water treaties between nations are key to regional stability. An agreement is needed between Turkey, Iraq and Syria over the Euphrates and Tigris rivers. Egypt, Sudan, Ethiopia, Burundi, Congo, Kenya, Rwanda, Tanzania, and Uganda, which share the Nile River, need an updated treaty. Only Egypt and Sudan recognize the 1959 treaty which does not allow for equitable water sharing. A water agreement is also needed for long term stability between Israel, Jordan and the Palestinian territories. The possibility of instability and migration issues in these regions is a security and economic concern for the United States and Europe. With mass populations moving into Europe and the United States, there are cultural concerns such as language and religion, political concerns brought about by large populations without employment, and health concerns which could lead to strains on the health care system. These concerns are based on a 2006 Pew Research Center survey, which found that 52% of Americans surveyed perceived immigrants to be a burden, as they take jobs, housing, and health care.[65] Finally, if these immigrants feel isolated or disenfranchised, they could turn to terrorism.[66]

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[64] Center for Strategic and International Studies (CSIS), *Global Water Futures: Addressing Our Global Water Future*, CSIS White Paper, September 2005, 101

[65] The Pew Research Center For the People and the Press, "No Consensus on Immigration Problem or Proposed Fixes: America's Immigration Quandary," Pew Research Center, http://people-press.org/report/274/americas-immigration-quandary, (accessed June 21, 2009)

[66] Oxford Analytica Daily Brief Service, "United Kingdom: Causes of UK Terrorism are complex," Oxford Analytica, http://proquest.umi.com/pqdweb? RQT=325&npc=3&pmid=100 128&TS=1245623119&clientId=39495&VInst=PROD&VName=PQD&VType=PQD, (accessed June 21, 2009). This is based on the 'failed integration hypothesis', this argument contends that the failures of immigrants and ethnic minorities to integrate leads to Muslim radicalization and eventual terrorist activity.

## SUMMARY

The initial challenge in solving the climate and fresh water problems facing each of these regions will be convincing both the governments of the regions and the international community of the need to be more proactive,[67] and address the issue before the situation becomes worse and harder to solve. Having the United States take the lead may be difficult, as there are competing priorities. The U.S. population may have a limited interest in issues facing these regions of the world, when compared to local issues. However, the consequence for not being proactive on water and climate issues is the potential for instability, that will affect the United States and Europe. In a globalized world, the instability that affects the United States and Europe could be as small as higher food and clothing prices due to a lack of water in these regions to grow exported products, higher fuel prices in regions that have the potential for conflict over water, or as large as mass migrations or terrorist attacks on the United States, as populations become hopeless.

Understanding water as a resource and how climate change is affecting that resource is a concern for the Intelligence Community. As water becomes scarce, the lack of proper management and planning will make certain parts of the world more unstable and potentially unlivable. According to the NIC, Climate Change will be a crucial factor,

[67] As Chapter 2 will show the issue of Climate Change caused by man made carbon emissions has been on the international agenda for over 20 years, but only recently has the United States begun to implement policies to reduce its greenhouse gas emissions.

creating a myriad of uncertain challenges, and may exacerbate existing instabilities worldwide, even if mitigation efforts are eventually successful.[68]

[68] The National Intelligence Council. National Intelligence Analysis. National Security Implications of Global Climate Change to 2030. Washington, DC: GPO, 10 June 2008, 10

# CHAPTER 2

# OVERVIEW OF CLIMATE CHANGE & WATER ISSUES IN THE MIDDLE EAST, NORTH AFRICA, & LATIN AMERICA

**"**Water is life. When there is no water there is no life. Between these two sentences lies the whole history of humanity."[69]

-Mohamed Ait-Kadi
Secretary General, Ministry of Agriculture and Rural Development, Morocco

## IMPLICTIONS FOR NATIONAL SECURITY

A national security analyst or high ranking military official could make the observation, that water issues and climate change are not issues that should concern them. This is important, as the focus of the United States Government and the media seems to be on imminent threats such as al-Qaida, Iran, or North Korea. Unless steps are taken now, climate change and its effect on water has the potential to affect regional stability. It is easy to believe that there are not any national security implications, and issues of climate change and water resource issues should be left to the environmental community, and not the intelligence community, to deal with. However upon review of various scholarly articles and books, along with recent National Security Strategies, environmental issues do play a role in security. The remaining paragraphs in this first section will focus on the recent history of environmental security and climate change,

[69] Mohamed Ait-Kadi, Secretary General, Ministry of Agriculture, quoted in Kirby, Alex and Spedding Vanessa, *The Boldness of Small Steps: Ten Years of the Global Water Partnership Sweden*: Global Water Partnership 2006, V

viewpoints from leading scholars, and why the United States needs to be concerned about the implications for National Security.

Environmental Security, as related to national security, is not a new concept. In 1977 Lester Brown stated: "threats to security may now arise less from the relationship of nation to nation and more from the relationship of man to nature. Dwindling reserves of oil and deterioration of the Earth's biological systems (land and water) now threaten the security of nations everywhere."[70] Without access to critical natural resources, states face risks to both internal and external conflict. In a 1983 journal article entitled "Redefining Security," Richard Ullman stated:

> Conflict over resources is likely to grow more intense as demand for some essential commodities increases and supplies appear more precarious. In considering ways in which such scarcities might affect national security, analysts should distinguish between those that arise from expansion of demand from those arising from restrictions on supply.[71]

Professor Ullman was able to foresee how increasing demand for natural resources in other parts of the world affect the National Security of the United States, and especially water scarcity in regions that contain critical US imports, such as food and energy. He came to this conclusion by redefining a threat to national security as anything that threatens to drastically reduce the quality of life for inhabitants of a nation over a period of time.[72]

In his 1988 National Security Strategy (NSS), President Reagan noted the importance of environmental security in relation to national security. One of the goals of

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[70] Lester Brown, "Redefining National Security" quoted in Campbell, Kurt M. ed. *Climatic Cataclysm: The Foreign Policy and National Security Implications of Climate Change*, Washington D.C.: Brookings Institution Press, 2008, 3

[71] Richard Ullman, 1983. *Redefining Security*, International Security Journal, Volume 8, Number 1 (Summer), 129-153

[72] Ibid., 133

President Reagan's NSS was for the United States to have friendly relations with all nations, with the goal of a progressive international order. President Reagan was aware that hindering this goal was:

> Critical shortages of food, lack of health services, and inabilities to meet other basic needs will keep millions of people, particularly in Africa, in peril. The dangerous depletion or contamination of the natural endowments of some nations-soil, forests, water, air-will add to their environmental and health problems, and increasingly to the global community. All create potential threats to the peace and prosperity that are in our national interest, as well as the interests of the affected nations.[73]

In short, it is the national interest of the United States to assist the global community in preventing environmental degradation, to include water scarcity, and to reduce the onset of climate change, before there are security implications. President Reagan understood that the United States must be proactive in working with other nations to solve natural resource issues, before they lead to a national security threat. Ten years later in the 1998 NSS, President Clinton stated: "Decisions today regarding the environment and natural resources can affect our security for generations. Environmental threats do not heed national borders and can pose long-term dangers to our security and well-being. Natural resource scarcities can trigger and exacerbate conflict."[74]

Environmental Security can be a political issue as evidenced by President's Carter's second National Energy Plan, which emphasized diversifying energy sources rather than relying on oil. In 1987, President Reagan's energy security report discussed

[73] The United States Government, *National Security of the United States*, Washington, D.C.: The White House, January 1988

[74] The United States Government, *A National Security Strategy for a New Century* Washington, D.C.: The White House, October 1998

the United States' dependence on foreign oil.[75] In an interview conducted with (b) (6) [redacted] at the US Army War College, he emphasized that environmental security issues should not be politics as usual, as it is a practical issue that everyone should care about. (b) (6) [redacted] emphasized that the threats posed to national security issues from environmental issues should not be turned into a political debate.[76]

In a 1989 Foreign Affairs article entitled "Redefining National Security." Jessica Tuchman Matthews stated: "The concept of national security must now be revised, so as to include awareness of mounting threats to the global environment. Environmental strains that transcend national borders are already beginning to break down the sacred boundaries of national sovereignty."[77] Critical water resources, that are in rivers and lakes which cross state borders, need to be distributed fairly. They also need to be governed by international treaties.

In the same Foreign Affairs article, Matthews showed that environmental security is composed of three pillars: 1.Threat Objectives, 2.Cooperation Measures and 3.Human Security Dimensions. An example of the threat objectives is when Turkey built the dams in its southeast; this is considered a threat to Iraq's water supplies. An example of a cooperative measure is the treaty negotiations between Israel and Palestine covering the issue of water. Another more recent example is the talks between the United States and China concerning Climate Change. These talks are important, as the United States and

[75] Clinton J. Andrews, "Energy Security as a Rationale for Government Action," Rutgers University, http://policy.rutgers.edu/andrews/projects/energy/energysecurity.doc, (accessed June 22, 2009)

[76] (b) (6) [redacted], interview by the author, Army War College, Carlisle, Pa, March 13, 2009

[77] Jessica Tuchman Matthews, "Redefining Security," Foreign Affairs Magazine, Spring 1989, http://www.foreignaffairs.com/articles/44331/jessica-tuchman-mathews/redefining-security, (accessed March 21, 2009)

China are two of the biggest emitters of carbon dioxide.[78] Drought that causes sheep herders to move to areas occupied by famers leads to instability, which is an example of the human security dimensions. Individuals should not be afraid that the environment they live may be racked with conflict, or unable to meet their basic needs for food, water, and shelter. [79]

The United States Environmental Agency defines Environmental Security as:

> a process whereby solutions to environmental problems contribute to national security objectives. It encompasses the idea that cooperation among nations and regions to solve environmental problems can advance the goals of political stability, economic development, and peace. In addition by addressing the environmental components of potential security "hot spots," threats to international security can be prevented before they become a threat to political or economic stability or peace.[80]

This definition was provided 10 years ago in 1999, and is still relevant today. To further illustrate the EPA's definition, a quote from Carol Browner, the EPA administrator in 1999 states:

> Protection of public health and the environment has become an important part of our national security. Environmental protection and economic growth go hand in hand; both are essential to U.S. long range security interests at home and abroad. By preserving the global environment we promote the peace and prosperity of America and its allies.[81]

A secure environment where critical resources such as land and water are available to the population, is critical to having a stable country, and treaties concerning land and water

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[78] Nationmaster, "Carbon Emissions (most recent) by country," Nationmaster.com, http://www.nationmaster.com /graph/env_co2_emi-environment-co2-emissions, (accessed June 21, 2009). A 2003 Report from the World Resources Institute found that the from 1850-2000 the United States was number one in the world with over 5 million metric tons of emissions and China was number two with over 3 million metric tons of emissions.

[79] Matthews, "Redefining Security"

[80] Environmental Protection Agency, *Environmental Security: Strengthening National Security Through Environmental Protection,* EPA Magazine, September 1999

[81] Ibid.

are critical for regional stability between nations. If water is not protected and available for a region's populations then the instability will result.

One of the goals in the 2003 National Strategy for Combating Terrorism is to diminish the underlying conditions that terrorists seek to exploit, which is part of a 4D strategy to defeat, deny, diminish and defend against terrorism.[82] One of the objectives is to strengthen weak states by "the rebuilding of a state that can look after its own people-their welfare, health, prosperity, and freedom-and control of its borders."[83] For a state to look after its own people it needs to meet Maslow's basic hierarchy of needs, primarily food and water. If there is not enough sanitized water to meet the population's needs, the state will become unstable, leading to conditions that terrorists can take advantage of. The document further states: "while not necessarily focused on combating terrorism, (these actions) contribute to the campaign by addressing underlying conditions that terrorists seek to manipulate for their own advantage."[84]

The strategy of using development to diminish the underlying conditions that terrorists seek to exploit is discussed by Elisabeth Kvitashvili, the director of conflict management and mitigation, U.S. Agency for International Development. She emphasizes that "USAID can play a key role in countering terrorism," and stated that, "In general, we must provide assistance that addresses the root causes or symptoms of

[82] The importance of the 2003 National Strategy for Combating Terrorism to water scarcity is that it shows how terrorists can use environmental issues to their advantage. The 2008 National Defense Strategy is also relevant as it mentions climate change and the environment as concerns for defense policy, see The United States Department of Defense, *2008 National Defense Strategy*, Washington D.C.: United States Government, June 2008, 4-5, 16

[83] The United States Government, "National Strategy for Combating Terrorism," entry posted February 2003, http://www.state.gov/documents/organization/60172.pdf (accessed March 21, 2009)

[84] Ibid.

conflict and the constraints to economic growth, such as issues over access to land, property, and natural resources."[85] USAID is working in unstable places such as northern Yemen to solve disputes over access to natural resources and using medical assistance to negotiate cease-fires. By fostering development even in small ways, such as providing wells to poverty stricken villages or teaching proper irrigation techniques so a village can have food, USAID is preventing terrorists from having a sanctuary or support in an unstable area. With water and other natural resource issues, it is best for the United States to be proactive in creating a stable environment, to prevent a breeding ground for terrorists like al-Qaeda. Natural resource issues are not the only cause of instability in a region, but they are a critical contributing factor.[86]

## CLIMATE CHANGE

### The History

A Swedish scientist, named Svante Arrhenius, was the first to see climate change as a potential danger over one hundred years ago.[87] However, it was not until the late 1980s that scientists had enough evidence to conclude that this phenomenon presented a clear threat to humanity. It was around this time it was realized that manmade greenhouse gases being released into the atmosphere were causing global warming.

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[85] Elisabeth Kvitashvilli, *The Struggles Against Extremist Ideology: Addressing the Conditions That Foster Terrorism, Chapter 4: The Role of Development in Combating Terrorism.* Edited by Kent Hughes Butts and Jeffrey C. Reynolds, Carlisle: Center for Strategic Leadership, 2005, 54

[86] Ibid., 45-55

[87] S.M. Enzler, "History of the greenhouse effect and global warming," LENNTECH. entry posted 2004, http://www.lenntech.com/greenhouse-effect/global-warming-history.htm, (accessed March 27, 2009)

James Hansen, a NASA scientist, testified before Congress in 1988 that he was 99% sure that the year's record temperatures were not caused by nature, but the growing concentration of $CO_2$ and other atmospheric pollutants.[88]

In 1988, the United Nations Environment Program and the World Meteorological Organization established the Intergovernmental Panel on Climate Change.[89] That same year a scientist from the Environmental Defense Fund named Michael Oppenheimer was quoted as saying: "Any race of animals clever enough to predict the warming of the earth 100 years ago should be clever enough to stop it."[90] Also in 1988, Canada hosted the first ever international conference on climate change. The conference was titled "The Changing Atmosphere: Implications for Global Security," and over forty countries attended. The Norwegian Prime Minister, Gro Harlem Brundtland, stated: "We are now realizing that we may be on the threshold of changes to our climate, changes which are so extensive and immediate that they profoundly affect the life of the human race."[91] Unfortunately, since that time not enough has been done to combat climate change.[92]

After Mr. Hansen's testimony, there were positive and negative developments concerning climate change. Fossil fuel companies mounted a counter-attack to his testimony. Skeptics said they were not sure how large a threat climate change possessed.

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[88] Linda Starke, ed. *2009 State of the World Into a Warming World: A Worldwatch Institute Report on Progress Toward a Sustainable Society,* New York: W.W. Norton & Company, 2009, 6

[89] Kurt M. Campbell, ed. *Climatic Cataclysm: The Foreign Policy and National Security Implications of Climate Change*, Washington D.C.: Brookings Institution Press, 2008, 4

[90] Ibid., 5

[91] Ibid., 3

[92] One reason for this conclusion is a May 2009 MIT study that projects global temperature to rise by $5.2^C$ by 2100, see Keith Johnson, "Climate Changes: MIT Study Says Temperatures Could Rise Twice As Much," Wall Street Journal, http://blogs.wsj.com/environmentalcapital /2009 /05 /19/climate-changes-mit-study-says-temperatures-could-rise-twice-as-much/ (accessed June 21, 2009)

Despite having Vice President Al Gore and Undersecretary of Defense Timothy Wirth in his administration, President Clinton did not take immediate action on Climate Change, as the perception was it would take large funds to properly tackle Global Warming at the same time forecasters were predicting a recession. The Clinton Administration focused on other issues, such as the economy, the Balkans, and domestic politics. President Clinton did propose the Climate Action Plan in 1993, which was to reduce emission levels to 1990 levels by 2000, but the entire plan was all voluntary. In 1992, the United Nations Framework Convention was adopted by the heads of state in Rio de Janerio.[93] During the early 1990s Vice President Al Gore wanted the "peace dividend" to be used to halt climate change and ozone depletion, but it was never initiated due to concerns over how it would affect the economy.[94]

In 1997, the Kyoto Protocol was negotiated by the international community, which established legally binding emissions limits for industrial countries. At the 1997 summit, President Clinton was prepared to reject stricter regulations on emissions based on advice from his economic advisors. He signed the Kyoto Protocol in 1998, but it was never sent to Congress for approval. In November 2000, climate negotiators met in Hague to finalize the Kyoto Protocol, but these negotiations failed to reach an agreement as an international system for reducing carbon emissions could not be finalized as there was disagreement over how nations would be penalized and how it would be enforced. The main issues were figuring out how to implement a global system to reduce carbon emissions and concerns about the economy. In March 2001, President Bush rejected the

[93] Starke, *State of the World,* 6

[94] Campbell, ed. *Climatic Cataclysm*, 4-8

implementation of the Kyoto Protocol, as he felt it may hurt economic prosperity, and the Global War on Terrorism took his focus away from climate change.[95]

In recent years, due to ongoing studies by the Intergovernmental Panel on Climate Change (IPCC) and security assessments such as the 2008 National Intelligence Assessment on Climate Change, world leaders have begun to understand the dangers posed by climate change. [96] President Obama understood the need to make the United States a leader in the fight to reverse the man made causes of global warming. As of May 2009, President Obama was pushing a climate change bill called the American Clean Energy and Security Act through Congress. The bill's main goal "is a greenhouse cap-and-trade program that aims to reduce emissions by 17 percent below 2005 levels by 2020, and 85 percent by 2050."[97] The bill to limit U.S. greenhouse gases was approved by the United States House of Representatives on 26 June 2009.[98] The intent is to have more environmental friendly jobs and technology, and reduce global warming. The bill will ensure creation of new industrial environmental standards and provide funds for international forestry projects.[99] According to the United States Department of State, the

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[95] Ibid., 8-10

[96] The National Intelligence Council. National Intelligence Analysis. National Security Implications of Global Climate Change to 2030, M.L. Parry, ed, et al. IPCC, 2007, Summary for Policymakers. In: Climate Change 2007: Impacts, Vulnerability. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge: University Press, 2007.

[97] Climate Biz Staff, "House Climate Change Bill Clears Key Hurdle," Reuters News Agency, entry posted May 22 2009, http://www.reuters.com/article/gwmCarbonEmissions /idUS39 4167898 220090523, (accessed May 25, 2009)

[98] Steven, Mufson, David A Fahrenthold, and Paul Kane, "In Close Vote, House Passes Climate Bill," The Washington Post, http://www.washingtonpost.com/wp-dyn/content /article /2009/06/26 /AR2009062600444.html?nav=hcmodule (accessed June 27, 2009)

[99] Climate Biz Staff, "House Climate Change Bill Clears Key Hurdle," Reuters News Agency, entry posted May 22 2009, http://www.reuters.com/article/gwmCarbonEmissions /idUS39 4167898 220090523, (accessed May 25, 2009)

U.S. is striving for an international agreement that will be a "post-2012 arrangement that is both environmentally effective and economically sustainable."[100] In 2008, the U. S. State Department hosted the International Conference on Renewable Energy Conference, and was attended by 113 countries. The United States is also part of the Asia Pacific Partnership with Australia, Canada, China, India, Japan, and the Republic of Korea, which is pursuing clean energy goals. At the recent Fifth Summit of the Americas, President Obama announced that the United States would promote renewable energy in Latin America to reduce greenhouse gas emissions.[101] In addition, publications by the Director of National Intelligence and the Center for Naval Analysis, warn of the national and international security implications posed by climate change.[102] These studies show that the United States understands the implications climate changes poses to its environmental security, and the stability of states that the United States has interests in.

**Rising Temperatures**

Global Warming can be summarized in five steps. Solar Radiation occurs (Step 1) and passes through the planet's atmosphere which contains greenhouse gases (Step 2). Solar radiation warms the surface of the earth and heat rises from the surface (Step 3). Some heat is able to pass through the gases (Step 4). However, some heat just cannot pass through the atmosphere, which adds to the earth's overall temperature (Step 5)

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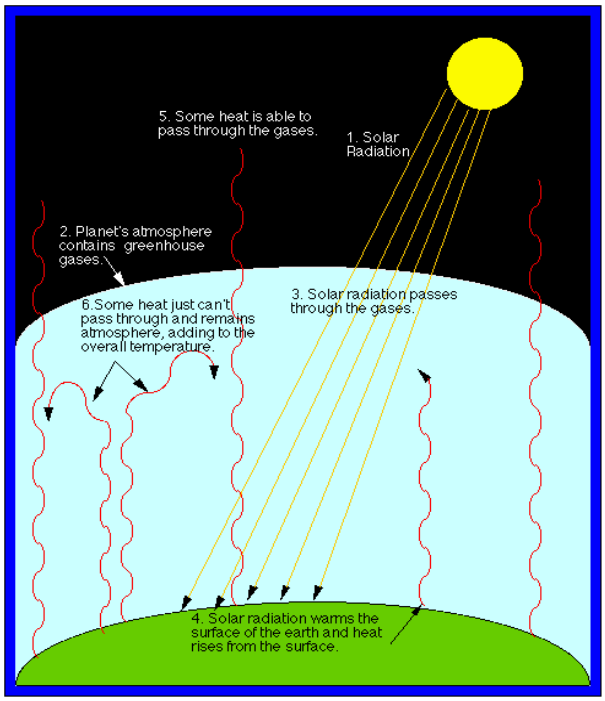
[100] U.S. Department of State, "Climate Change," http://www.state.gov/g/oes/climate/, (accessed May 25, 2009)

[101] Ambassador Reno L. Harnish, "Promoting the Use of Renewable Energy Worldwide," U.S. Department of State, entry posted April 2009, http://www.state.gov/documents/organization/123400.pdf, (accessed May 24, 2009)

[102] The Center for Naval Analysis. *National Security and the Threat of Climate Change*. The CNA Corporation. Alexandria, Va 2007; The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030.* Washington, DC: GPO, 10 June 2008,

(Chart 2-1).[103] To understand the security implications posed by climate change, the team from the National Intelligence Council that is studying the regional effects of climate change needs to understand the basics of climate change, which is being caused by Global Warming.

**Chart 2-1 Components of Global Warming**



[104]

A certain amount of green house gases in the atmosphere is normal and occurs naturally. The two elements that make up the majority of GHGs are carbon dioxide and water vapor. They act as a blanket for the radiation that comes from the earth's atmosphere and warms the planet's surface. The problem is that human activities, such as the burning of fossil fuels and the removal of forests, have increased the amount of

[103] Sawvel, *Water Resource Management*, 23

[104] Nick Hopwood and Jordan Cohen, "Greenhouse Gases and Society," University of Michigan, entry posted March 1998, http://www.umich.edu/~gs265/society/greenhouse.htm (accessed March 27, 2009)

carbon dioxide in the atmosphere by 35% since the beginning of the industrial age, which is having various effects on the environment.[105]

Rising temperatures in certain regions of the world, especially parts of South America, is having a profound effect on glaciers, which are critical to supplying fresh water to remote regions. "Even a one degree rise in temperature in mountainous regions can markedly reduce the share of precipitation falling as snow, and boost that (amount) coming down as rain. This, in turn, increases flooding during the rainy season, and reduces the snowmelt to feed rivers during the dry season."[106] The concern among most analysts is that the lack of glaciers to provide fresh water will cause migration of populations, along with possible loss of agriculture production.[107] An area being observed in South America concerning melting glaciers, is in Quito Ecuador.

Casey Brown, a Columbia University climate scientist states "Managing water supplies in a warmer, more variable climate is a challenge developing countries are facing right now."[108] As glaciers melt due to global warming in parts of Latin America, populations have to rely on less and less mountain water runoff. Quito, Ecuador, a city of two million, depends on water from the fast-retreating Antizana glacier. The country has laid out projects to expand its water supplies to provide for the city's growth through 2040. The plans have not factored in global warming which could add $100 to $300

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[105] Hevre Treut and Richard Somerville, *Historical Overview of Climate Change. In Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge: Cambridge University Press, 2007

[106] Lester R. Brown, *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble*, New York: W.W. Norton & Company, 2006, 66

[107] Ibid., 66-74

[108] Sawvel, *Water Resource Management,* 18

million to the pipeline projects. These pipelines will need to be extended further up and around the glacier's mountain.[109]

The Center for Naval Analysis recognized the dangers posed from rising temperatures and their effect on fresh water availability. "Changes in rainfall, snowmelt and glacial melt have significant effects on fresh water supplies, and climate change is likely to affect all of those things. In some areas of the Middle East tensions over water already exist."[110] Furthermore some areas that are considered arid regions will become more arid and the need for water will increase.

**Rising Sea Levels**

Warming temperatures will cause rising sea levels to occur, due to the loss of ice masses covering Greenland and the Antarctica, and could result in a sea level rise between .18 and .59 meters which is predicted by the Intergovernmental Panel on Climate Change (IPCC).[111] In 2002, scientists from the University of Colorado observed that glaciers from Northern Canada and the west coast of Alaska were melting at an accelerated pace, adding to sea level rise. Scientists are more concerned about the melting of glaciers on the land, as the ice melting in the Arctic Sea will not affect sea level rise as the ice is already in the sea. However, in 2005, scientists came to the conclusion that warming temperatures are causing Arctic ice to melt fast enough that its absorbing heat from the sun, and resulting in a cycle as the absorption causes the ice to

[109] Ibid., 17-18

[110] The Center for Naval Analysis. *National Security and the Threat of Climate Change*, 13

[111] Starke, *State of the World,* 15

melt even further. If the entire ice sheet covering Greenland were to melt, sea levels could rise by 7 meters.[112]

Rising sea levels will lead to salt water seeping into the soil along coastlines, requiring a need to either relocate populations or create desalination plants in regions that may not be able to afford them. "One third of the world's population lives within 60 kilometers (about 37 miles) of a coastline, so potential refugee crises are of critical concern if the widespread sea levels rises predicted by scientific models occur."[113] Population shifts may create conflict and or add stress to lands that can barely support the existing population.

**Chart 2-2 Coastal Populations**


Source: Burke et al., World Resources Institute, Washington DC, 2001; Paul Harrison and Fred Pearce, *AAAS Atlas of Population and Environment 2001*, American Association for the Advancement of Science, University of California Press, Berkeley.[114]

[112] Brown, *Plan B 2.0,* 68-74, 251

[113] Campbell, ed. *Climatic Cataclysm,* 14

[114] United Nations Environmental Programme, "Coastal Populations and altered coastal zones." entry posted 2002, http://maps.grida.no/go/graphic/coastal-population-and-altered-coastal-zones, United Nations, (accessed March 27, 2009)

As the sea levels rise, the salt water will seep into the soil and affect underground aquifers along with the efficiency of the desalination plants. This will decrease the amount of water in areas such as the Middle East, which are already over-pumping their aquifers due to population growth, and are reliant on desalination plants.[115] The Center for Naval Analysis observes that the salinization of the aquifers is already an issue for the Gaza Strip, and they are concerned with how it could affect agriculture in the Middle East, further destabilizing the region.[116]

**Projected Immigration**

Projected Migrations will occur due to an increase in water scarcity and a decrease in arable land. The security implications posed for the United States are that some of these potential migrations will involve Mexico and residents from northern Latin America migrating to the United States, and residents of North Africa and the Middle East migrating to Europe. This would be caused by global warming and overconsumption of limited water sources. Rural populations, whose land can no longer support agriculture, will be the most vulnerable, and they may have to rely on government subsidies for support. In parts of Latin America, Climate Change will cause the soil to become more saline and other parts will become more arid, due to the rising temperatures. These projected migrations will cause severe stress on state economies as migrants move from rural areas to urban areas, or from dry regions to wet regions, in search of work. In the face of these projections, governments have done little planning to

[115] Mohammed A. Raoof, *Climate Change Threats, Opportunities, and the GCC Countries*, The Middle East Policy Brief, April 2008, 1-15

[116] The Center for Naval Analysis. *National Security and the Threat of Climate Change*, 30

assist their populations such as developing industries that are less dependent on natural resources.[117] This is due to what the United Nations Environment Programme refers to as the "resource curse," which hypothesizes that countries with an abundance of natural resources grow less than those that do not.[118] Countries in all three regions use wealth from oil or from crop production to fuel their economy, rather then invest in resource independent industries.

As the International Organization for Migration (IOM) notes,

> The meteorological impact of climate change can be divided into two distinct drivers of migration; climate processes such as sea level rise, salinization of agricultural land, desertification and growing water scarcity, and climatic events such as flooding, storms and glacial lake outburst floods. But non-climatic drivers, such as government policy, population growth and community-level resilience to natural disaster, are also important. All contribute to the degree of vulnerability people experience.[119]

The study by IOM found that forced migration diminishes the health and education of migrants, destabilizes urban services and infrastructure, increases the possibility of conflict, and decreases economic growth. The organization is concerned that climate migrants are not included under current international refugee and immigration policy.[120] The concern for intelligence analysis is that this will lead to an increase in illegal immigrants.

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[117] Lori M. Hunter, "Climate Change, Rural Vulnerabilities, and Migration," Population Reference Bureay, entry posted June 2007, http://www.prb.org/Articles/2007/ClimateChange inRuralAreas.aspx, (accessed May 26, 2009)

[118] Yanchun Zang, "Discussion of the Paper "Institutional Quality, Economic Policy and the Effect of Commodity Booms across Industries" by Nicolas M. Chauvin," United Nations Development Programme Office of Development Studies, www.undp.org/developmentstudies/docs /discussion _aea_jan09.pdf, (accessed June 22, 2009)

[119] Oli Brown, *Migration and Climate Change*, Switzerland: International Organization for Migration, 2008, 9

[120] Ibid., 10

The Center for Naval Analysis predicts three different types of migrations that will add to global tensions. The first is internal migrations. These can be difficult for developed countries like the United States, as incidents like Hurricane Katrina have shown, and will be even more unmanageable for countries like Venezuela or Iraq. The second type of migration pattern is crossing international borders such as when citizens of Bangladesh migrated to India in the latter part of the 20th century because of a reduction in arable land. The parts of India that they migrated to suffered economically and resulted in violence between the migrants and the natives. The third version of migration is when migrants move across regions such as immigrants from Asia and Africa moving into Europe, which caused strife in France in 2005 along religious and racial lines.[121] The importance of understanding the three different types of migration is that all three affect the U.S. National Security, as each has the potential to create instability in parts of the world where the United States has key interests.

The 2008 National Intelligence Assessment on Climate Change predicts that: "The largest inflows are likely to mirror many current migratory patterns- from North Africa and Western Asia into Europe, Latin America into the United States, and Southeast Asia into Australia."[122] What is unclear is when those migrations would occur; predictions indicate sometime between now and the next 30 to 100 years, which is very vague.[123] The United States is not immune to the problem, as it will be dealing with increased severe storms in the Gulf Coast region, and drought in the Southwest.

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[121] The Center for Naval Analysis. *National Security and the Threat of Climate Change*, 17-18

[122] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030,* 25

[123] Ibid., 13, The Center for Naval Analysis. *National Security and the Threat of Climate Change*, 6, 16,

Combined with something like the current economic crisis, a rapid increase in immigration and the subsequent population demands will not be easy to deal with.

**International Conflict**

In May 2007, the National Security Implications of Climate Change was the topic of a hearing held by the Senate Foreign Relations Committee. Senator Lugar was quoted as saying: "the problem is real and is exacerbated by man-made emissions of greenhouse gases. In the long run this could bring drought, famine, disease, and mass migration, all of which could lead to conflict."[124] The challenge for the United States is to take a leadership role in the fight against global warming, enact policies that strive to reduce or reverse its effects, and encourage other countries to do the same.

Climate change is only adding to already existing tensions over freshwater. Some articles have suggested that water will the "oil of the 21st century".[125] "In the 1980s, Egyptian Foreign Minister Boutros Boutros Ghali warned that the next war in the Middle East would be over water."[126] The Middle East is already a region that has conflict between nations due to religious reasons, water scarcity, compounded by climate change will only make the situation worse.

[124] Starke, *State of the World,* 64

[125] Andrew Clearly, "Is Water the oil of the 21st Century?", entry posted July 24, 2008, http://www.cnbc.com/id/25828315, (accessed June 11, 2009)

[126] Campbell, ed. *Climatic Cataclysm,* pg. 3

# WATER MANAGEMENT ISSUES

## Supply & Demand

Water management is the practice of planning, developing, distributing, and optimum utilization of water resources under defined water polices and regulations.[127] Furthermore, water management must include issues such as irrigation, sewage, energy, transportation, recreation, health, and sanitation. For better or worse, water resources do not recognize national boundaries, and in most cases there are not established agreements in place to resolve ongoing conflicts. Governing bodies need to manage their region's water supplies to ensure there is enough to meet their population's needs.

Although the amount of fresh water throughout the world has remained constant, the demands on it have increased, along with the amount that has become polluted. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO):

> The looming water crisis is one of the most critical challenges facing the world today. Global demand for this precious resource has increased more than six fold over the past century compared to a three fold increase in world population. Without better management two-thirds of humanity will suffer from severe or moderate shortages by the year 2025.[128]

Various organizations, such as the Global Water Partnership and the World Water Council, are striving to establish international laws concerning water rights, but none have been established to date.

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[127] Neil S. Grigg, "Integrated Water Resources Management," Water Encyclopedia, entry posted 1996, http://www.waterencyclopedia.com/Hy-La/Integrated-Water-Resources-Management.html, (accessed May 24, 2009)

[128] The United Nations Educational Scientific and Cultural Organization (UNESCO), quoted in Sawvel, Patty Jo., ed. *Water Resource Management: Introducing Issues with Opposing Viewpoints*, Farmington Hills: Green Haven Press, 2008

According to the Global Water Partnership: "Our expanding populations and accelerating productivity caused flows to deplete, water tables to fall, sources to become polluted. This imperative for humanity to change, to become more judicious in its use and management of this vital resource was not realized until the late 20th century."[129] To summarize this statement, in certain regions of the world the population is demanding more water than what the region can provide, and a lack of regulations only adds to the problem. Chapter 3 shows that the Middle East is an example of demand outpacing supply, and Chapter 4 will show that bad management practices have hurt parts of Latin America. International organizations, such as the World Health Organization, may be able to develop international standards for drinking water, but they have no way of enforcing them, have limited funding to provide the countries that need it, and cannot change depleted reservoirs and aquifers.

Growing populations, along with the globalized world's demand for biofuels, is putting increased stress on the environment and is already creating what some writers refer to as the "politics of scarcity".[130] Climate Change adds to the problem with increased heat waves and droughts, which lead to an increased loss of crops, along with falling watering tables. Water tables are falling, due to a lack of precipitation, increased evaporation, over pumping of aquifers, and a lack of soil moisture with increased runoff. The over pumping of underground water and lack of precipitation to replenish it is the main concern. Melting glaciers are causing water tables to fall in certain parts of the

[129] Alex Kirby, and Vanessa Spedding, *The Boldness of Small Steps: Ten Years of the Global Water Partnership* Sweden: Global Water Partnership 2006

[130] Joyce Starr, Daniel Stoll, *The Politics of Scarcity: Water in the Middle East,* Boulder Westview Press, 1988 1-198

world, which affects that region's ability to harvest crops. As glacier runoff increases in the short term, soil moisture may increase, but a portion will be carried downstream. One French researcher "believes that 80 percent of South American glaciers will disappear within the next 15 years,"[131] further decreasing the supply. Without the runoff from glaciers to rivers, there is less water for irrigation and decreased soil moisture during the dry season. Water demand has exceeded supply, and certain areas of the world may face a catastrophe in the near future.[132]

Some researchers argue that water crises occur when there is mismanagement of water resources, rather than a water shortage. In their view the mismanagement of the water is leading to a shortage, as the water is not replenished and is improperly distributed. In some cases, even if the water was properly managed, there is not enough to support the growing population that is demanding more of it than the region can provide."[133] Since there is a limited amount of freshwater, regulations and policies need to be enforced to ensure all citizen's needs are met. USAID states: "industrialization, irrigated agriculture, massive urbanization, rising standards of living, and, of course, more people are pushing the demand for freshwater to new heights, undermining already fragile water security for many nations."[134] Global demand for water has tripled in the past 100 years, is currently doubling every 21 years, and cannot be sustained. Effective

[131] Kirby, and Spedding, *The Boldness of Small Steps*, 69

[132] Ibid., 57-63, 66-74

[133] Kirby, and Spedding, *The Boldness of Small Steps,* 1-105

[134] USAID, "The Global Water Crisis," http://www.usaid.gov/our_work/environment /water /water _crisis .html , (accessed May 26 2009)

water management practices are needed to prevent the water crisis from becoming worse than it already is.[135]

To further illustrate the supply and demand issues placed on freshwater resources, researchers C. Raleigh and H. Urdal measure demand induced scarcity by population growth. Raleigh and Urdal analyzed supply induced scarcity by land degradation, water scarcity, and population density. Their findings showed that these factors are likely to produce multiple points of stress, which could act as triggers for resource scarcity conflicts. However, they believe that political and economic factors will play a larger role, along with how critical resources such as fresh water are distributed among the populations.[136]

In places like the Sonoran desert, where reservoirs along the Yaqui River are drying up due to overuse by farmers, which means less water for future agricultural use. In dry countries such as Egypt and Mexico, 90% of the water used is for irrigation. The world may grow twice as much food as it did twenty-five to fifty years ago, but it uses three times as much water to do it.[137] The further down in the ground farmers pump for water the more it costs, the water quality becomes worse, and the underground sources are further depleted due to over pumping.[138]

Researcher Diane Raines Ward states: "As humanity grows thirstier in the earth's driest places, or is threatened by flooding rivers and encroaching seas in wetter ones, the

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[135] Ibid.

[136] Ragnhild Nordas, and Nils Peter Gleditsch, eds. *Climate Change and Conflict*, Political Geography, New York: Elsevier Publishers, August 2007, 674-694

[137] Fred Pearce, *When the Rivers Run Dry: Water-The Defining Crisis of the Twenty-First Century*, Boston, Beacon Press, 2006, 24-25

[138] Ibid., 57-63

steady rise in population puts stress on the land and water."[139] The world's population is almost seven billion and increasing by ninety million every year.[140] As the increasing population is putting more demand on the water resources through more agriculture production involving large scale irrigation, and dumping fertilizers and pesticides into the rivers, it is becoming more difficult to meet the demand.[141]

**Water and Food**

The report from the Center for Naval Analysis states:

> To live in stability, human societies need access to certain fundamental resources, the most important of which are water and food. The lack, or mismanagement, of these resources can undercut the stability of local populations; it can affect regions on a national or international scale.[142]

The stability of a region due to a lack of food and water is a concern for the United States, as it could become a breeding ground for terrorist organizations.

According to Lester R. Brown, a leading environmentalist: **"**If countries that are over pumping do not move quickly to reduce water use and stabilize water tables, then an eventual drop in food production is almost inevitable."[143] This, in turn, will limit food production and lead to seemingly irrational acts on the part of nations. There is a limited

[139] Ward, Water Wars, 3

[140] Ibid.

[141] Ibid.

[142] The Center for Naval Analysis. *National Security and the Threat of Climate Change*, 18

[143] Brown, *Plan B 2.0,* 58

amount of ground water available. There are already discussions between Israel and Turkey of Israel paying Turkey to export fresh water to Israel on large vessels.[144]

With a changing climate, existing agricultural regions will face greater challenges, as the precipitation cycles change and the amount of precipitation decreases. It is estimated that more than a billion people depend on water irrigation for agriculture, and that it is dependent on man made reservoirs.[145] As precipitation decreases, along with increased temperatures which will lead to increased evaporation, there will be less moisture in the ground. Less moisture in the soil will affect the amount of crops the region is able to produce, and even building foundations. With precipitation occurring more in some areas than in others, this may affect established reservoirs, and irrigation systems. This scenario could lead to decreased crop yields and food shortages for regional populations. Regional stability would be affected, with the potential for social unrest and economic collapse. Other national security implications are the potential for migrations out of the affected area, and conflict over dwindling water resources. There are also economic security concerns for the United States, as food prices would rise and the United States would have a moral obligation to provide humanitarian aid.[146]

Another challenge for agriculture in dry regions is that soil can become too salty, which is referred to as salinization. Water usually moves salt minerals to rivers and streams, but if there is a lack of water, then the salt remains in the soil. On the other hand, large amounts of water can cause the salt to seep into the plant roots. Solutions for

[144] Ward, Water Wars, 194

[145] Ibid., 21, 51

[146] Ibid., 105-132. See pages 2-3 for affected areas

salinization include giving plants a little extra water to remove the salt, or building underground pipes to remove excess water.[147]

With regards to water usage and agriculture, of the 80% to 90% used in fields, only 50% of that makes it to the crops.[148] Unfortunately, proper irrigation knowledge is slow to get to developing countries, which contributes to water waste. The countries in the Middle East and North Africa region could benefit from practices the Israelis use, such as computer controlled drip irrigation. The World Watch Institute believes that if global irrigation efficiency was improved by 10%, then the needs of everyone on the planet would be met.[149]

Again, according to Lester R. Brown,

> Each year the gap between world water consumption and the sustainable water supply widens. Each year the drop in the water table is greater than the year before. Both aquifer depletion and the diversion of waters to cities will contribute to the growing irrigation deficit and hence to a growing grain deficit in many water short countries.[150]

This quote shows that the level of water scarcity across the globe is steadily getting worse, as population growth continues to over consume, and not replenish, a finite resource. As populations shift from rural areas to urban areas, due to economic reasons, those urban areas will require more water which is usually diverted from the rural or agriculture sectors. Researchers estimate that 70% of water usage is for irrigation, 20%

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[147] Voice of America, "Agriculture Report- May 21, 2002: Irrigation and Salt," entry posted May 20, 2002, http://www.voanews.com/specialenglish/archive/2002-05/a-2002-05-20-2-1.cfm (accessed March 5, 2009)

[148] Ward, *Water Wars*, 105

[149] Ibid., 121

[150] Brown, *Plan B 2.0,* 56

for industry, and 10% for residential usage. As populations increase, it is the farmers that will lose out to the needs of the urban populations. As the water tables have decreased and as water is diverted to urban areas, countries in arid regions are competing with each other for grain imports to feed livestock. It is estimated that 14 tons of water is needed to make a ton of steel worth $550, whereas it takes 1,000 tons of water to produce a ton of wheat worth $150.[151] It is not hard to understand why farmers come out on the losing end in the battle for water. As more and more countries compete with each other for outside grain sources, the price will continue to rise. Already, the Middle East and North Africa regions are considered to be the world's largest grain importer. [152] Understanding how water is and will be allocated is important to this study, as not only will climate change decrease the amount of arable land due to prolonged drought and floods, but water resources will decrease for agriculture, as they are diverted from agriculture to urban areas. Eventually this will affect stability, as arable land for grain and other crops is unable to keep pace with consumption. There is not be enough water for irrigation, due to both urban growth and climate change.[153]

Challenges arise when the importers of grain products require more than what the exporters can provide, as they are affected by climate change and internal population growth. Current assessments show that countries such as Saudi Arabia and Egypt are already importing more food than what they are producing.[154] The food situation is only

[151] Ibid., 55

[152] Ibid., 55-56

[153] Joel K. Bourne, "The End of Plenty, Special Report: The Global Food Crisis," *National Geographic*, June 2009, 26-59

[154] Ward, Water Wars, 224

made worse when major exporters such as Brazil are affected by climate change. This loss of land for agriculture would further drive up the economic cost for regions such as the Middle East and North Africa.[155]

**Aquifers**

An aquifer is "an underground layer of rock which holds fresh water and allows water to percolate through it."[156] The two basic types are replenishable and non-replenishable or fossil aquifers. In the case of fossil aquifers, depletion brings pumping to an end so precipitation is key to preventing depletion.[157] The layer of rocks in an aquifer can consist of sandstone, gravel, limestone, and granite. Water moves through the soil through cracks until it reaches a zone of saturation which is filled with water. The water can not move any further down into the soil as the rock below it is impermeable. As the aquifers or water tables are depleted, deeper wells are needed which increases the cost of pumping and adds a financial burden to the inhabitants.[158]

To add to the food scarcity issue, as more countries continue to over pump their aquifers, especially the non replenishable or fossil aquifers, a scenario may arise where multiple countries have completely drained their aquifers. This may not happen all at once, as different aquifers have different levels of underground water. However, this

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[155] The Center for Naval Analysis. *National Security and the Threat of Climate Change*. 15, 30

[156] Yara Corporation, "Resource Glossary," entry posted 2007, http://citizenship.yara.com/en /resources /glossary/index.html, (accessed May 24, 2009)

[157] Ibid.

[158] Mark McGinley, "Aquifer," entry posted February 6 2007, http://www.eoearth.org/article /Aquifer, (accessed May 26, 2009)

scenario could lead to unmanageable food scarcity issues, as the food or grain demand will outweigh supply.

Of the top fifteen countries over pumping their aquifers, nine are in the Middle East or North Africa: Iran, Israel, Jordan, Morocco, Saudi Arabia, Syria, Tunisia and Yemen.[159] The United States, Mexico and Spain are also on the list. Proper planning, to include control measures and international agreements, is the only way to mitigate the problem.[160]

**Rivers**

Rivers are a source of replenishment for lakes and aquifers; as they dry up or are diverted; it is the farmers that suffer. It is estimated that 50% of the world's rivers are either polluted or drying up. Climate change is contributing to the drying up of rivers, but the main cause is the demand being placed on certain rivers, due to the growing populations in dry climates.[161] Rivers are also critical for supplying reservoirs and dams which are used for hydroelectric power production. [162]

Rivers as a source of fresh water are sometimes shared by multiple countries. In the case of the Tigris and Euphrates rivers which originate in Turkey, actions taken by Turkey have adverse effects on other countries such as Iraq, Syria, Jordan, and Israel. The same can be said for the Rio Grande, which is shared by both the United States and Mexico, and the Nile which is shared by Egypt, Sudan, Tanzania, Uganda, Ethiopia,

[159] Brown, *Plan B 2.0,* 43

[160] Ibid.

[161] Ward, Water Wars, 3

[162] Ibid., 154-6

Kenya, Zaire, Rwanda, and Burundi. "Almost ½ the earth's land lies in river basins shared by at least two nations and 80% of the world's available fresh water flows through international river basins."[163] The result of this fact is that there are tensions between nations as the fresh water is not shared evenly between the countries, and there are very few treaties in place to resolve the issues. The country where the river originates usually has the upper hand. As mentioned in Chapter 1, emphasis will be placed on how a lack of water security may lead to instability. [164] A nation cannot guarantee water security when it does not have a written agreement or treaty with the nations it shares a water resource. All the nations need to abide by such treaty and understand how much water they need.

There are over 200 international river basins and 176 of them are shared by only two countries.[165] Researcher Aaron T. Wolf reports that there are four stages to negotiations between countries that share and depend on water from the same river. They are: Stage 1. Assess the Current Setting: Basins with Boundaries; Stage 2. Changing Perceptions: Basins without Boundaries; Stage 3. Enhancing Relations and Benefits: Beyond the River; Stage 4. Bringing it all Together: Institutional and Organizational Capacity and Sharing Benefits.[166] Stage 1 involves trust building, listening, and conflict resolution concerning political issues to allow for cooperation. Stage 2 moves from what

[163] Ibid., 188

[164] See water security definition on page 21

[165] Shlomi Dinar, "Assessing side-payment and cost sharing patterns in international water agreements: The geographic and economic connection," in "Conflict and Cooperation over International Rivers," ed. Sara McLaughlin Mitchell, special issue, Political Geography 25, no. 4 (May 2006) 412-437

[166] Aaron T. Wolf, "Rationality, Spirituality and Shared Waters," Journal of International Affairs Volume 61, no. 2, {Spring/Summer 2008}65-68.

a country feels it is entitled to what it needs from the river and the focus is on the future and not the past. Stage 3 focuses on problem solving and solutions, and discussions also focus on all the benefits of the river such as shared hydroelectric power. Stage 4 focuses on executing the plans so that they will be sustainable over the long term and that the distribution of the water is fair and equal between the countries. Wolf believes that:

> It is anticipated, however that the dangers of scarcity-driven suffering and conflict will only increase with population growth, poverty and global change. Yet as grows the threat to increased conflict in the future, so too grow the opportunities for dialogue and healing.[167]

Since water from the rivers that cross boundaries are a common dependence, it creates a pathway to discuss mutual interests, rather than destructive differences.[168]

**Desalinization**

As climate change, population growth, overuse, and pollution deplete surface and underground water supplies, to prevent instability new fresh water supplies need to be found or created. One such method is desalinization. Desalinization involves removing salts from the water. Traditional methods involve evaporation of the water and collection of the condensation. Thermal power can be used to remove the water from the salt brine, or high voltage current can be used to separate the cations and anions from the water stream. A third method is reverse osmosis, which involves the use of membranes to

[167] Ibid., 69

[168] Ibid., 51-69

separate the salt from the water. Some of these methods can be energy intensive, and can contribute to global warming by the amount and types of fuels it uses in the process.[169]

On the surface, desalination sounds like a good solution to the world's growing demand for fresh water, but it does have its issues. From a moral standpoint, one can argue that human beings are misusing their freshwater resources, so now the population is turning to salt water, which is home to various plants and animals. Desalination often involves pumping concentrated salt waste (also known as brine) back into the ocean, which kills various plants and animals. The intake of saltwater also kills various fish larvae. The fuels that many Desalination plants use add to global warming.[170]

Scientists are developing more cost effective and environmental friendly methods of desalination. Some of these methods involve using carbon nanotubes, which are more than 50,000 times thinner than a human hair. Billions of nanotubes form a membrane that can quickly separate water molecules from salt. This method can be compared to a garden hose that can deliver as much water as fast as a fire hose that is ten times larger. An added benefit is that it is low cost and energy efficient. In addition, some desalination plants in places like Australia are able to draw 100% of their energy from wind power.[171]

**Hydroelectric Power**

In certain parts of the world, nations depend on water not only for sustenance, but for electricity as well. Hydroelectric Power involves building a dam where the river has a

[169] Dr. Val Frankel, "Desalination Methods, Technology, and Economics," IDS, IDS-Water Information Resource Center entry posted 1998, http://www.idswater.com/Common/Paper/Paper_90/Desalination%20Methods, %20Technology,%20and%20Economics1.htm, (accessed May 27, 2009)

[170] Sawvel, ed. *Water Resource Management*, 7-9

[171] Ibid.

large drop in elevation. There is a reservoir built behind the dam for storage and at the bottom of the dam is a water intake valve. The moving water travels through the valve and pushes a turbine. The moving turbine creates power which is connected to power lines to carry the electricity to industrial and residential areas.[172] Hydropower supplies 20% of the world's energy. Climate Change could affect hydroelectric power in countries such as in Peru, that depend on glacial runoff to fill their reservoirs. The problems with hydroelectric dams are that they are expensive to build and maintain, they can damage the environment due to land loss through their construction, and they are a single point of failure for electricity, thus vulnerable to attack.[173]

Many nations that possess large rivers and lakes turn to hydroelectric dams for power; however, one of the problems that arises is that the dams are not always built in effective locations. Sometimes large dams are built that are unable to support the region, rather than building strategically placed smaller dams. Another negative aspect of hydroelectric plants is that they are expensive, and destroy massive amounts of land during the building process.[174]

Brazil, which relies on dams for 90% of its electricity, still falls short of its electrical needs. The country also suffers during times of drought, which forces it to ration electricity. Because of reservoir emissions and flooding of jungles, dam reservoirs can produce as much as 7% of the world's greenhouse gas emissions. Due to the

[172] Howard Perlman, "Hydroelectric Power: How it works," United States Geological Survey, entry posted May 14, 2009, http://ga.water.usgs.gov/edu/hyhowworks.html, (accessed May 27, 2009)

[173] Ward, Water Wars, 154

[174] Ibid., 155

maintenance costs of some electrical lines, combined with the cost of building them, it is too expensive to run lines to remote areas.[175]

**Pollution**

Water Pollution is an issue across the globe; as internationally, it is not illegal to dump harmful toxins such as sewage, industrial chemicals, garbage and sludge into both freshwater and saltwater basins. It is believed that 50% of all sewage is dumped into water basins, and between one and ten billion tons of oil are dumped into the water systems every year. The problem is intensified in urban areas, due to the amount of urban and residential waste being dumped into the nearby rivers.[176]

A member of the Intelligence Community can be vulnerable to the influences of the mass media, and be misled as to what the critical issues really are. Unfortunately a plane crash in Buffalo that kills fifty people or a boat capsizing in Florida that kills two NFL players, captures more time in the twenty-four hour news cycle than issues concerning water.[177] While such incidents are tragic, they pale in comparison to the yearly deaths from unclean water. As stated in the book Water Resource Management by Patty Jo Sawvel:

> Unclean water kills more people than wars do. The 1.8 million child deaths each year related to unclean water and poor sanitation dwarf the casualties associated with violent conflict. No act of terrorism generates economic devastation on the

[175] Ibid., 156

[176] Think Quest, "Water Pollution-Causes," http://library.thinkquest.org /26026/Environmental _Problems/water_pollution_-_causes.html, (accessed May 25, 2009)

[177] CNN, "Search for answers begins in Buffalo Plane crash," entry posted February 13, 2009, http://www.cnn.com/2009/US/02/13/plane.crash.new.york/index.html, (accessed May 24, 2009) and David Goodhue, "Boat Carrying Two NFL Players Lost at Sea," All Headline News, entry posted March 1, 2009, http://www.allheadlinenews.com/articles/7014258504, (accessed May 24, 2009)

> scale of the crisis in water and sanitation. Yet, the issue barely registers on the international agenda.[178]

The concern is that action may not be taken until it is too costly to reverse the water issues in certain regions.

Pollution is an issue of concern for the regions being studied in this thesis as it negatively affects the status of water resources, and leaves less clean fresh water for the needs of the population. National economies will eventually be affected, if efforts are undertaken to sanitize the polluted water. In Venezuela, oil and fertilizer runoff along with untreated sewage seep into the underground aquifers, along with the lakes and rivers, which decrease the amount of safe, clean, drinking water for the population. In August 1999, reports showed that the PdVSA, Venezuela's national oil company, was charged with $1.5 million in environmental liabilities.[179] The city of Damietta, Egypt has a high rate of diseases caused by water pollution, which has caused some of the citizens to be infected with liver and kidney infections. The river is infected with industrial wastewater and garbage from the city's households. The Egyptian government has been putting regulations on industrial waste dumping, to decrease the amount of water pollution.[180] Partially due to the ongoing war, parts of the Tigris River in Iraq are filled with pollution, such as oil, sewage waste, plastic bottles, toxins, residential garbage dumping into the river, and industrial waste. The smell from burning plastic and raw

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[178] Sawvel, ed. *Water Resource Management*, 35-36

[179] Corrosion Doctors, "Pollution and Deforestation in Venezuela," http://corrosion-doctors.org/AtmCorros/mapVenezuela.htm, (accessed May 24, 2009)

[180] United Nations Foundation, "Water Pollution Provokes Disease," entry posted September 15, 2009, http://www.unwire.org/unwire/19990915/4806_story.asp, (accessed May 25, 2009)

sewage is overwhelming in certain areas.[181] The dumping of sewage waste into the Tigris and Euphrates Rivers has been an issue in both Syria and Iraq. The dumping of sewage and industrial waster is also an issue in the Parana-La Plata River Basin, and is mostly caused by Brazil and Argentina. In 1978, the United Arab Emirates, Iran, Iraq, Kuwait, Oman, Qatar, and Saudi Arabia agreed to combat pollution, but the agreement is not being enforced. To solve the issue, international treaties need to be implemented and enforced in the regions, and the populations need to be educated.[182] Pollution, along with overconsumption of water, is decreasing the water availability in these regions, and climate change will only add to the increasing water scarcity.

**Disease**

Rising water temperatures, due to global warming, will cause an increase in the spread of diseases, as a study titled "The Deadly dozen" by the Wildlife Conservation reported in 2008.[183] These diseases include: ebola, cholera, tuberculosis, yellow fever, intestinal parasites, avian influenza, babesiosis, lyme disease, plague, red tides, rift valley fever, and sleeping sickness. The spread of these diseases could put additional strains on countries that are having difficulty managing already existing issues. Security analysts should pay attention to reports on these diseases after periods of severe storms and

[181] Inter Press Service, "Water Crisis hits Iraq," entry posted February 12, 2009, http://www.huffingtonpost .com /2009/02/12/water-crisis-hits-iraq_n_166517.html, (accessed May 25, 2009)

[182] Arun P. Elhance, *Hydropolitics in the Third World: Conflict and Cooperation in International River Basins*, Washington DC: United States Institute of Peace, 1999, 29. 128-129

[183] Wildlife Conservation Society, "The Deadly Dozen: The Wildlife Conservation Society sounds the alarm on Wildlife-Human Disease Threats in the age of Climate Change," entry posted October 7, 2008, http://www.wcs.org/deadly-dozen/wcs_deadly_dozen (accessed May 26, 2009)

prolonged droughts. This is another example on how climate change is affecting the water supply in these regions. Members of the National Intelligence Council are studying such cases, to better understand how climate change will impact regional stability.[184]

Research has shown how pollution is affecting the health of the water supply in the region. One example is how water borne diseases can be spread by the dumping of human and animal feces, which harbor pathogenic microorganisms, into water systems that are consumed by unknowing downstream populations. Researchers from the Lenntech Corporation in the Netherlands, which develop water treatment systems, found that "in developing countries four-fifths of all the illnesses are caused by water-borne diseases, with diarrhoea being the leading cause of childhood death."[185] It is believed that 1.1 billion people lack access to safe drinking water and 2.5 billion people lack quality sanitation, which has led to over 2 million deaths a year and places a preventable burden on the developing world.[186]

Unfortunately large irrigation projects in developing countries have sometimes led to an increase in disease due to standing water, which results in an increase in mosquitoes and snails. The diseases carried by these vectors include cholera, gastrointestinal diseases, diarrhea, dysentery, malaria, skin diseases and eye diseases.[187]

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[184] Ibid.

[185] LENNTECH, "Water Diseases," http://www.lenntech.com/Waterborne-diseases/waterborne-diseases.htm, (accessed May 26, 2009)

[186] Ibid.

[187] Ibid., 5, 69.

Researchers found that irrigation projects in the Tigray region in Ethiopia, led to an increase in Malaria as the standing water became a breeding ground for mosquitoes.[188]

**Privatization vs. Government**

From a moral standpoint, every human being has a right to an adequate amount of fresh water that is sanitary and affordable. "The right to water does not mean that it's free of charge, but individuals are entitled to water that is affordable."[189] Of all the natural resources water is the most critical. Regions of the world need to have enough water for agriculture, power, and residential use. Water management is a huge factor in the water problems facing the developing world. A 2003 report by the United Nations estimated a cost of $110 to $180 billion to provide safe water to the developing world. Its goal is to reduce by 50% the number of people without access to safe drinking water, as 2005 estimates show one billion people lack access.[190] The most important issue is distribution, so that the poor are provided with an adequate amount of water. A debate rages as to whether water management should be handled by the government or private sector.[191]

It is important to understand, when studying how a lack of water security can lead to state instability, that such events are often not always due to a lack of water, but rather due to mismanagement of existing resources. Some researchers argue that an increased

[188] United Nations Foundation, "Irrigation Spurs Disease in Ethiopia," entry posted September 13, 2009, http://www.unwire.org/unwire/19990913/4747_story.asp, (accessed May 26, 2009)

[189] Sawvel, ed. *Water Resource Management,* 1

[190] Ibid., 39

[191] Ibid.

role for the involvement of private enterprise in water distribution "can save millions of lives and give water connections to hundreds of millions of people who today are deprived of it."[192] In Guinea before privatization took over in 1989 only 20% of the urban population had access to safe water and in 2001 70% of the population had it. [193] The price of piped water may have risen from 15 cents to a dollar per cubic meter, but it has allowed the majority of the urban population to have water. As an outsider, private enterprise can enter a country and ensure equal distribution of water, as they should not favor one group of citizens (wealthy, poor, urban, rural), whereas governments may favor the wealthy and those organizations or individuals that support them, and neglect or overcharge the poor.[194]

Other researchers argue that governments should oversee water management as private enterprise can be corrupt and mismanaged. Governments are accountable to their citizens and international organizations to ensure water is properly distributed, but the problem is that some governments are either incompetent or too corrupt. Another problem is that governments in developing countries do not have the funds to treat their water, properly supply their population, and provide efficient irrigation without seeking international aid.[195]

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[192] Fredrik Segerfeldt, *Water For Sale: How Business and The Market Can Resolve The World's Water Crisis*, Washington D.C.: CATO Institute 2005, as quoted in Sawvel, ed. *Water Resource Management*

[193] Sawvel, ed. *Water Resource Management,* 41

[194] Ibid., 38-44

[195] Ibid., 45-50, and The British parliamentary Office of Science and Technology, "Access to Water in Developing Countries," entry posted May 2002, http://www.parliament.uk/post/pn178.pdf, (accessed May 27, 2009)

## WHY THE UNITED STATES SHOULD BE CONCERNED

### The Blame Game

The United States makes up 4.6% of the world's population, but accounts for 20% of fossil fuel emissions.[196] With the rise of Brazil, China, India, and the continued growth of the United States, global emissions of $CO_2$ from fossil fuels rose from 22.6 billion tons in 1990 to 31 billion tons in 2007, a 37% increase.[197] As the world becomes more globalized, will other parts of the world being willing to listen to the United States? The United States needs to be proactive in addressing climate change so as to prevent its national security implications. One way this can be done is by influencing other nations to curb their carbon emissions, and helping to forecast how climate change will impact their water resources.

The National Intelligence Assessment has found that climate change has the potential to aggravate poverty, social tensions, and worsen already existing environmental degradations. Weak political institutions already threaten domestic stability in parts of Africa and Asia, which will be unable to handle the issues brought about from climate change. The world will look to the United States for leadership and assistance, although some may look upon the United States with resentment for contributing to the problem. The only way to prevent the world from looking at the

[196] Linda Starke, ed. 2009 *State of the World Into a Warming World: A Worldwatch Institute Report on Progress Toward a Sustainable Society*, New York: W.W. Norton & Company, 2009, 7

[197] Ibid.

United States with resentment for contributing to the problem, is for the United States to take a proactive role in reducing its contributions to global warming.[198]

As shown by the current world economic crisis, what happens in one country may have profound consequences for the economies of other countries. "The United States depends on a smooth functioning international system, ensuring market access to critical raw materials such as oil and gas, and security for its allies and partners, Climate change could affect all of these- domestic stability in a number of key states, the opening of new trade routes, and the significant geopolitical consequences."[199] As climate change affects access to natural resources, some countries may become wealthier and others poorer. The countries that are affected in a negative way may become unstable. Both scenarios will cause the price of certain resources such as wheat or oil to rise, as the countries that have increased access to a resource will charge more, and the ones that have less access will have to use more funds to gain what they need. Either leads to greater social inequities, one of the leading causes of conflict, which will only aggravate the situation. It is clearly in the United States' interests to break this escalating cycle of conflict.

[198] The National Intelligence Council. National Intelligence Analysis. National Security Implications of Global Climate Change to 2030. 5-7

[199] Ibid., 10

# CHAPTER 3

## WATER ISSUES IN THE MIDDLE EAST & NORTH AFRICA: HOW CLIMATE CHANGE IS IMPACTING THEM

"The Middle East is home to 5% of the world's population and only 1% of its renewable water resources."[200]

-Diane Raines Ward

Researchers and analysts are aware of how serious the water issues are in the Middle East and North Africa. In his book *Resource Wars*, Michael Klare states,

> This danger (of conflict) is particularly acute in areas where rainfall is scant and several countries depend on a single major source of water-the Nile River, the Jordan, the Euphrates, and so on-for their basic needs. Unless ways are found to reduce these states' per capita use of the available supply, any increase in utilization by one country in the system will result in less water being available-to the others- situation that could lead to the outbreak of war.[201]

Leaders in the Arab states seem to understand how critical the issue is, but are unable to move beyond political divides.[202] In 1997, a conference was held on water issues that was attended by 17 Arab states. Unfortunately, Israel and Turkey, which are key to water issues in the region, were not invited.[203] This is important as the Tigris and Euphrates rivers which are used by Syria and Iraq originate in Turkey, and the water resources for Jordan, Lebanon and the Palestinian territories are controlled by Israel.

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[200] Ward, *Water Wars,*188

[201] Klare, *Resource Wars,*139

[202] This conclusion is drawn from the shared water resources between Israel, Syria, Lebanon, Jordan and the Palestinian territories such as the aquifers, Jordan River, and Yarmuk River. Rather than work together to solve the water scarcity issues, the countries are pursuing their own solutions such Israel's water agreement with Turkey, while overpumping the underground aquifers. In addition Arab Leaders recognize that efforts to curb carbon emissions affect their economic prosperity.

[203] Ward, *Water Wars,* 194

According to researcher Franklin M. Fisher:

> There are four major disputes over water in the Middle East: control of the Karun River, or Shatt-al-Arab (Iran and Iraq); the Euphrates River (Turkey, Syria, and Iraq); the Jordan River (Syria, Israel, Lebanon, Jordan and the PNA); and the coastal and mountain aquifers (Israel and the PNA). These conflicts cause instability in the region, so resolving them would be a good first step in building confidence and initiating a peace process throughout the region.[204]

This quote is important since if the disputes over the shared water resources were resolved, the region would become more stable, trust could be restored, and other issues could be resolved that have nothing to do with water. Addressing the water disputes should lessen the water stress, and allow for the more equitable sharing of the water. Fisher further notes that North Africa and the Middle East make up the driest region in the world. Each year, the region has access to 355 billion cubic meters of renewable water resources, compared to 5,379 billion cubic meters in North America.[205] Analysts believe that 75% of all the water in the Middle East is contained in Iran, Iraq, Syria, and Turkey.[206] This means that "roughly two-thirds of the Arab world depends on sources outside their borders for water. The most direct effect of climate change to be felt in the Middle East will be a reduction in precipitation."[207] This scenario would be a cause for concern even in a region without the Middle East's history. The situation becomes more critical as populations continue to grow and the water tables fall. The water tables are

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[204] Franklin M. Fisher and Hossein Askari, "Optimal Water Management in the Middle East and Other Regions," entry posted September 2001, http://www.imf.org/external/pubs /ft/fandd/2001/09/ fisher.htm, (accessed April15, 2009), 2

[205] Ibid., 1

[206] Kurt M. Campbell, ed., *Climatic Cataclysm: The Foreign Policy and National Security Implications of Climate Change*, Washington D.C.: Brookings Institution Press, 2008, 105

[207] The Center for Naval Analysis. *National Security and the Threat of Climate Change*. The CNA Corporation. Alexandria, Va 2007, 30

falling as the countries are over pumping their aquifers to support growing populations, and not replenishing them due to a lack of precipitation. In 1950, the population of the Middle East was around 100 million; it is projected to be over 600 million by 2050.[208]

The importance of this, from a U.S. National Security perspective, is the potential over the next 40-50 years is for the Middle East/North Africa (MENA) area to grow from 385.6 million to 719.4 million by 2050, causing a natural increase in the demand for limited water affecting regional stability.[209] The Middle East will have to import more 'virtual water,'[210] in the form of agricultural products. Worldwide, there is only so much more land that can be used for agriculture, and modern techniques can only meet a small portion of this increased demand. A national security analyst, who is concerned about the stability of the region, along with the potential for conflict and migration over dwindling water resources, must pay attention to facts such as how much 'virtual water' is being imported, and at what rate this is increasing each year. Falling water tables, due to both a reduction in precipitation and overuse, will pose a challenge to regional agriculture production, leading to an increase in virtual water. Additional attention should be paid to the amount of oil revenues each country has, as this revenue will be used to pay for the increase in agricultural imports.

One of the key questions of this research is what is the status of the region(s) that the Middle East imports water from. The Middle East and North Africa imports water in the form of food or other products. Kuwait imports 100% of its food; Iran, Egypt, and

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[208] Campbell, *Climatic Cataclysm,*107

[209] Population Reference Bureau, "Population Trends in the Middle East and North Africa," Population Reference Bureau, www.prb.org/pdf/PoptrendsMiddleEast.pdf, (accessed 22 June 2009)

[210] Virtual water is the amount of water embedded in food or other products.

Turkey import 30% of theirs.[211] One of the locations the Middle East imports virtual water is the United States. The United States exports over 500,000 tons of flour to Egypt.[212] Another major exporter of flour to the Middle East is the European Union, which exports two million tons of flour to Libya, Iraq, Yemen, and the UAE every year. The Middle East's growing population affects the West's ability to meet the demands, so Pakistan is looking to export sugar, livestock, and dairy to the Middle East.[213] Middle East countries such as Saudi Arabia and Kuwait are looking to import food from Nigeria.[214] For now, these countries or regions are able to meet the Middle East's increasing demand, but in the long term, they may not be able to, and demand will exceed supply and affect regional stability.

Climate change and limited arable land will affect the exporters' ability to meet the demand in both positive and negative ways. Estimates by the International Water Resource Management show that Pakistan will be under water stress by 2025.[215] However, observing temperature rise over the past 100 years and its affect on climate, the IPCC predicts that North America and northern Europe will experience increased crop production.[216]

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[211] Michael Kurtzig, "Imports Rising in Middle East and North Africa," Agricultural Outlook www.ers.usda.gov/publications/agoutlook/jun1999/ao262c2.pdf, (accessed June 23, 2009)

[212] Ibid.

[213] Fresh Plaza: Global Fresh Produce and Banana News, "Pakistan farm sector eyes major share of GCC's $200b food imports," FreshPlaza.com, http://www.freshplaza.com/news_detail.asp ?id=21249, (accessed June 23, 2009)

[214] Femi Odulana, "In the interest of Nigeria's agriculture," The Guardian, http://www. ngrguardiannews.com/editorial_opinion/article04/indexn2_html?pdate=240309&ptitle=In%20the%20interest%20of%20Nigeria's%20agriculture, (accessed June 23, 2009)

[215] The Center for Naval Analysis. *National Security and the Threat of Climate Change*, 15

[216] IPCC

According to research by the Intergovernmental Panel on Climate Change (IPCC), the Mediterranean Region, which includes parts of the Middles East and North Africa, is subject to the most significant impacts from climate change. It is believed that soil moisture has decreased 10% or more in parts of the Mediterranean basin; research indicates decreased rainfall, increased summer drought, and warmer than global mean temperatures.[217] This decrease in soil moisture is important, as it highlights the decrease in arable land in the region, thus forcing the population to import more food. If the Middle East and North Africa are unable to import enough food, the potential exists for instability in a region that the U.S. has key interests in. Due to both climate change and overuse, as the water supplies diminish the countries in the Middle East and North Africa may turn to nuclear power for desalinization. However, cooling for these nuclear plants would be limited, due to the limited availability of water.[218] There is no proof that this will occur, but there is speculation based on numerous plans for nuclear reactors in the region. Recent events include Algeria's plan to build a nuclear power station in 2020, and Egypt met with a contractor in December 2008 to design a nuclear power plant. Other related events include Iran's plan to start another nuclear power plant in 2009. In 2008, Jordan conducted negotiations with a French contractor, to build a nuclear reactor. In February 2009, Kuwait's ruler acknowledged considering nuclear power to meet electricity and water desalination needs.[219]

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[217] Campbell, *Climatic Cataclysm*, 70, 74

[218] Ibid., 219-220

[219] Reuters News Agency, "FACTBOX: Nuclear power plans across the Middle East," Reuters, http://www.reuters.com/article/worldNews/idUSTRE5384EF20090409, (accessed June 22, 2009)

Across the globe, there is limited new land to develop agriculture, most land has been developed, or is too remote to be practical. To look for indicators and warnings of a pending food crisis based on water scarcity, an analyst should pay attention to all the contributing factors. These factors include: population growth; declining water tables; changing diets; and a demand for more virtual water due to an increase in droughts that impairs internal food production, which will lead to higher food prices, and increased social stress.

The National Intelligence Assessment predicts that by 2020, the Middle East will experience a temperature rise of 1degrees Celsius; precipitation will decrease between 3-8% in the winter and spring, and increase 5 to 18% in the summer and fall.[220] Chart 3-1 shows how some of the countries in the Middle East will be impacted by climate change, and the increased population demands on the limited fresh water resources:

[220] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030.* Washington, DC: GPO, 10 June 2008, 15

**Chart 3-1 Impact of Climate Change on selected Middle East countries**

| Socioeconomic Impact | Iraq | Jordan | West Bank and Gaza | Syria | Lebanon |
|---|---|---|---|---|---|
| Increased industrial & domestic water demand | Medium | Insignificant | Insignificant | Medium | Medium |
| Increased agricultural water demand | High | Insignificant | High | High | High |
| Water resource equity decline | High | High | High | High | Medium |
| Food damage | High | Insignificant | Insignificant | Insignificant | Medium |
| Water quality damage | High | High | High | High | High |
| Hydropower loss | Insignificant | Insignificant | Insignificant | Insignificant | Medium |
| Ecosystem damage | Medium | Insignificant | Medium | Medium | High |
| GDP reduction in % | 3-6 | 1-2 | 2-5 | 4-7 | 2-5 |

221

A national security analyst from the National Intelligence Council who is studying the regional effects of climate change must pay attention to the water quality damage and the increased agricultural water demand, as food prices may increase, causing hunger and social instability. This scenario has security implications for countries such as Iraq and Syria, which might initiate conflict with Turkey and Jordan, in addition to population migration. If a conflict were to occur, the United States would have to become involved due to its strategic interests in the region.

Researchers at the International Development Center in Canada believe that the time for business as usual concerning water resources in the Middle East and North Africa is over.[222] They feel that countries in the region should no longer build larger

[221] The World Bank (2007) Making the Most of Scarcity: Accountability for Better Water Management in the Middle East and North Africa, quoted in International Development Research Centre – Canada, "Water Demand Management: A No-Regrets Adaptive Strategy to Climate Change in the Middle East and North Africa Region," entry posted 2008, http://network.idrc.ca/uploads/user-S/12209477751abs531_poster.pdf, (accessed April 16, 2009)

[222] Ibid., 1-2

dams, dig deeper wells, and expand irrigated areas, as this is too expensive, and damaging to the local ecosystem. Even with such efforts, fresh water is being depleted and degraded at an alarming rate.[223]

## NORTH AFRICA

### Libya

Libya is composed of 1,759,540 square kilometers, of which 90% is desert. Its population is over 6.3 million, with .6 cubic kilometers of fresh water resources available.[224] It is considered the driest nation of its size on earth, with water scarcity the main environmental issue facing the country.

Libya's leader, Col. Muammar Abu Minyar al-Qaddafi, created the Great Manmade River, whose first phase opened in 1991. It pumps the world's greatest reservoir of freshwater from beneath the Sahara to the coastal cities.[225] "The giant Nubian sandstone aquifer is the largest liquid freshwater source on earth containing around 50 billion acre feet of water in a series of basins. The rivers comprise a 2,000 mile network of pipes. Their water comes from a network of pipes. The water comes from hundreds of networks of boreholes sunk up to a third of a mile into the sand in the middle of the Sahara desert."[226] As of 2006, the project has cost almost $27 billion, and

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[223] Ibid., 1-2

[224] CIA- The World Fact Book, "Libya" entry updated March 19, 2009, https://www.cia.gov/library/publications/the-world-factbook/print/ly.html, (Accessed March 22, 2009)

[225] Fred Pearce, *When the Rivers Run Dry: Water-The Defining Crisis of the Twenty-First Century*, Boston: Beacon Press 2006, pgs X1, 45-48

[226] Ibid,, pg 45

has been spearheaded by Haliburton. Approximately 600,000 acre feet of fossil water is moved yearly. It takes nine days for the water to cross the 600 miles of desert to reach the coastal cities. [227] The concern is that it is unknown how much of the 50 billion acre feet of water can be extracted from the ground. The aquifer not only flows under Libya, but Egypt, Chad, and Sudan. Those countries could conduct similar projects, and further decrease the amount available to Libya. Increased tensions are likely without an international agreement concerning underground water, and a lack of cooperative measures which could allow for a treaty between the countries.[228]

**Map 3-1 Libya**

229

A second phase of the river project has been completed, but it delivers only one fifth of the intended water, as it has had to maneuver through mountains and canyons to link the capitol of Tripoli into the project. Three more phases are planned, to combine

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[227] Ibid., 45-48

[228] Kendra Patterson, "A Case for Intergrating Groundwater and Surface Water Management," in Troubled Waters: Climate Change, Hydropolitics, and Transboundary Resources, edited David Michel and Amit Pandya, 63-72, Washington D.C.: Henry L. Stimson Center, 2009

[229] Nick Brooks, "Fezzan Project- Study Area," entry posted 2002, http://www.cru.uea.ac.uk/~e118/Fezzan /Fezzan _studyarea.html (accessed May 18, 2009)

the already finished rivers and extend the first one at a cost of billions of dollars. The project has been stalled, due to a South Korean steel company going out of business and corrosion which has caused some of the pipes to burst. Qadaffi is attempting to deliver 1.6 million acres of fresh water to the coastal area where the people are. "Most are on the coast where over pumping and an invasion of seawater into aquifers have left irrigated soils so salty that many wheat fields have perished."[230] The hard fact is that even with this new project, Libya's demand is exceeding its supply. Once the five phases of the project are complete, Libya will still need three times more water to be independent from agriculture imports. The goal for the Libyan government is to be self-sufficient in agriculture, and not have to rely on imports. The long term security implications for the United States are that eventually self-sufficiency will not be achieved. Libya will be in competition with its neighboring countries for a limited amount of food imports, and eventually regional stability will be further degraded as demand outpaces supply.[231]

[230] Pearce, *When the Rivers Run Dry,* 48

[231] Ibid., 45-48

**Map 3-2 Egypt**

[232]

## Egypt

The Nile River, which is Egypt's sole source of water, supports nine countries: Burundi, Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda. It is considered the longest river in the world, as it travels from Rwanda/Tanzania to the Mediterranean Sea. Its tributaries include the White Nile, the Blue Nile, and the Atbara rivers. The Nile River covers a 675 mile distance in Egypt, and supports the country's agriculture production.[233]

"From the Egyptian perspective, control of the Nile and all of its headwaters is essential to the survival and well-being of the country."[234] Egypt has a population of over

[232] Michal Barron, "Maps of the Nile," entry posted 2006, http://www.mbarron.net/Nile/bigmp_nf.html (accessed April 15, 2009)

[233] Klare, *Resource Wars,* 149-152

[234] Ibid., 151

69 million, and the country is 97% desert. The country's land mass was not meant to support that population, and the manmade dams and canals will cause problems in the future, in the forms of land that cannot support crops. Egypt has constructed two dams on the Nile River, the Answan Dam (1939) and the High Dam (1971). The Nile River will soon be used to its full capacity. Even now, salt needs to be flushed out of some of Egypt's fields.[235]

To ensure it would continue to receive the same amount of water from the Nile, in the 1929 Nile Waters Agreement, Egypt made sure that no water projects would occur on the Nile's waters in the other countries without Egypt's approval.[236] In the 1940s, the other countries that benefit from the Nile voided the 1929 agreement, which caused Egypt to view the Nile as a national security matter.[237] Egypt signed an agreement with Sudan in 1959, that gave Egypt the right to 55.5 billion cubic meters and Sudan the right to 18.5 billion cubic meters.[238] Some of the other seven countries that benefit from the Nile have had issues with this agreement, such as Somalia, Ethiopia and Eritrea. The agreement prevents them from pursuing projects that would give them more of the Nile's waters and reduce Egypt and Syria's percentages. Ethiopia has agricultural ambitions to divert water from the Nile, and Uganda has visions for multiple hydroelectric projects. With all the countries experiencing population growth, they all will demand more from the river, thus a sharing agreement is needed. Egypt, which has a superior military and

[235] Ward, *Water War,* 57, 197-200

[236] Klare, *Resource Wars,* 152

[237] Ibid, pg. 152

[238] Abiodun Alao, *Natural Resources and Conflict in Africa: The Tragedy of Endowment*, Rochester: University of Rochester Press, 2007, 215-221

greater economic resources than the other countries along the Nile River, will be hesitant to give up any of its share for the greater good of the region.[239] Unless an international agreement can be reached, conflict between Egypt and the other countries that depend on the river remains a distinct possibility. Unfortunately Egypt is only concerned about what is best for its own interests, and not what is best for the region. As long as Egypt has the upper hand, this situation will continue.[240]

The Nile River Basin Initiative (NBI) could serve as a basis for resolving future water resource conflicts, as it is a starting point for a water sharing agreement or treaty that all the countries could agree upon. Constructed in 1999 to allow for the sharing of scientific information, it now gives ministers a forum to discuss ways to better share the Nile's water resources. There have been no recent conflicts over the Nile, as the NBI allows for peaceful communication and open dialogue. It will be tested in the future, based on demands from the countries that depend on it. "The Nile River Basin Initiative (NBI) is a partnership initiated and led by the riparian states of the Nile River through the Council of Ministers of Water Affairs of the Nile Basin states."[241] The Nile River is expected to increase the volume it carries between now and 2030, but the demands on the

[239] The CIA World Fact Book, "Country Reference," CIA, https://www.cia.gov/library /publications/the-world-factbook/index.html, (accessed June 23, 2009). The CIA ranks Egypt's military 39th in the world and shows Egypt has a GDP of 442.6 billion which ranks it 28th in the world. By comparison the CIA ranks Sudan's military 51st in the world and with a GDP of 87.27 billion is ranked 71st in the world.

[240] Klare, *Resource Wars,* 152-160

[241] The Nile River Basin Initiative, "Nile Basin Initiative," entry posted 2009, http://www.nilebasin.org/, (accessed April 16, 2009)

river will also increase. Countries, such as Ethiopia, Kenya, and Egypt, will negate the benefits of the increased flow, due to economic development and population increases.[242]

Climate change will add to Egypt's water issues as sea level rise will not only affect the coasts, but will cause the underground water from the Nile River to become more saline. Further, as precipitation decreases, and rising temperatures increase evaporation, farmers will demand more from the underground water supply. Farming will become even more difficult, as some crops can not prosper. As sea levels rise, Egypt will lose needed fertile land that is essential to feeding its growing population. The rise in sea levels will cause saline water to seep into the groundwater along with the Nile delta, and negatively impact the crops. Increases in severe storms will also have a negative impact on the fields. [243] Egypt's own government forecasts almost 1.5 million residents along the coast having to migrate due to sea level rise, which will also affect stability.[244]

Because of the High Dam, the river area in Egypt no longer receives a yearly flooding, the land is saturated with fertilizer, waste, and sewage. Various diseases are spread from the Nile reservoir, such as malaria and schistosomiasis, a parasitic worm that lines the veins around the bladder and intestines.[245] As temperatures rise due to climate change so will the threat from dengue fever and cholera, as the pathogens will have a

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[242] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030.* 23

[243] The Center for Naval Analysis. *National Security and the Threat of Climate Change*. The CNA Corporation. Alexandria, Va 2007, 30. Egypt is tied with Japan as the world's largest grain importer as it imports 40% of its grain.

[244] Wagdy Sawhel, "Climate change in Egypt 'to force millions to migrate,' " Science and Development Network, http://www.scidev.net/en/news/climate-change-in-egypt-to-force-millions-to-migr.html, (accessed June 23, 2009)

[245] Ward, *Water Wars, 69*

greater lifespan and increased survivability.[246] Beyond the loss of life, the increase in disease will place another financial burden on the government, as it will also have to pay for more food imports due to loss of farm laborers. The rising temperatures will lead to water borne diseases which will have an adverse effect on the region. Countries will bear the burden of increased medical costs as more people succumb to these diseases.

**Sudan**

The White Nile begins in Burundi, moves through Lake Victoria and then into Sudan where it links up with the Blue Nile. The Blue Nile flows west from the Ethiopian highlands into Sudan, where with the White Nile then flows north of Khartoum, the capitol of Sudan. They link up with the Atbara Tributary, which flows into Sudan from the Ethiopian highlands.[247]

[246] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030.* 24

[247] Abiodun Alao, *Natural Resources and Conflict in Africa,* 215-6

**Map 3-3 Sudan**

[248]

Sudan wants to use its profits from oil to irrigate its portion of the Sahel Belt. Ethiopia has stated that any Sudanese effort to take water from the Nile would incur a military response. Egypt will initiate military operations with Sudan or Ethiopia or both, over any effort by either country to change the flow of the tributary waters to the Nile.[249]

An armed conflict involving Sudan and Egypt over water resources is not an unrealistic scenario as the growing populations of both countries will demand more water than what they are currently using. Egypt's population is expected to increase from 65.7

[248] Jonildo Bacelar, Geographic Guide, "Sudan Map- Africa," http://www.geographicguide.net /africa /sudan.htm (accessed May 18, 2009)

[249] Klare, *Resource Wars,* 152-160

million in 1998, to 115.5 in 2050; Sudan's population is expected to increase from 28.5 in 1998 to 59.9 million in 2050.[250] These projections are based on research done by the World Resources Institute in 1998. With both countries almost doubling their populations in the future, they will have to decrease agricultural production and import more food, or demand more from the Nile. This will lead to conflict with the other nations, unless a new agreement can be formalized. There are security implications in either scenario, as importing more food will cause international food prices to rise, while conflict threatens a region rich in oil, and located near the Middle East where hundreds of thousands of U.S. troops are deployed.

In 1994 Egypt sent troops into the Halayeb district, where the Red Sea lies along a disputed border area.[251] If Sudan were to exceed its allocated amount of water from the Nile, Egypt could overwhelm Sudan with its superior numbers. It is also possible the two countries would team up if the upstream countries threaten to take additional water from the Nile, in the form of dams and irrigation projects. In the absence of an agreement between all nine countries, armed conflict remains a distinct possibility.[252]

Like Egypt, Sudan had plans for the Nile River, which included constructing the Jonlei Canal. This was halted in 1984, due to the civil war and building the Roseries Dam on the Blue Nile.[253] For Sudan and Egypt to avoid large scale conflict over the Nile, they need to keep the lower riparian countries in line. This means they need to threaten the lower riparian countries with military force, to ensure they do not take more

[250] Ibid., 157

[251] Ibid., 159

[252] Ibid., 154-160

[253] ICE Case Studies, "Blue Nile," entry posted 1997, http://www1.american.edu/ted/ice/bluenile.htm, (accessed June 19, 2009)

water than what they are authorized in the 1929 agreement. In the future, it will be more challenging for the lower riparian countries as their populations continue to grow. However, Sudan may no longer be satisfied with the 1959 agreement with Egypt, especially in the south, as residents are not pleased with the plans for the Jonglei Canal (supported by Egypt and the Sudan government) as it would drain the Sudd swamp that so many of them depend on. A potential dispute over the Nile only adds to Egypt's concerns about Sudan's links with Islamic fundamentalism and international terrorism. In turn, Sudan's support for Islamic fundamentalism in Egypt may be related to concerns over the Nile.[254] Sudan and Egypt are working with their neighbors to ensure each country receives an adequate amount of water from the shared resource. The paper will now focus on Morocco, a country facing critical internal water issues.

**Morocco**

Morocco faces its own challenges concerning water. Its water quality is considered poor, due to pollution from wastewater, leakage from fertilizers, and soil erosion. This issue is made worse by the country's overall lack of water, due to its climate and growing population. "Morocco has today water resources of about 700 m3 per capita/year, which is below the scarcity threshold of 1000 m3/per capita/year set by the UN Development Programme."[255] The levels could be as low as 500m3/per

[254] Abiodun Alao, *Natural Resources and Conflict in Africa, 217-9*

[255] Euro-Mediterranean Water Information System, "Morocco: SPI-Water Conclusions from the Sebou River Basin in Morocco," entry posted November 18, 2008, http://www.emwis.net/thematicdirs /news /morocco-spi-water-conclusions-sebou-river-basin, (accessed April 16, 2009)

capita/year by 2020.[256] Morocco's main source of water is the Sebou River Basin, where 20% of the population lives off of the river.[257]

If climate changes worsens enough that populations begin to migrate to Europe, the main migrant routes will be through Libya and Morocco. It is possible that climate change could cause conditions in the region to worsen over the next thirty years, with temperatures rising 4.7 degrees Fahrenheit (2.6$^{C}$) over 1990 levels, along with decreasing rainfall and decreasing crop yields.[258] In this scenario, immigrants from North Africa pouring into Europe could become impossible to stop without the use of force.[259]

As the demand for water increases, watershed revegetation is increasing. Water revegetation is turning areas such as forests and grasslands into vegetable fields, which are needed as countries face both population growth and water scarcity. Green water, which is water stored by vegetation, can be just as important as blue water, in preventing water runoff and soil erosion, which results in wasted water. In Morocco, thirty-four pastoral cooperatives with over 8,000 members have rehabilitated 450,000 hectares of land. Community involvement is key to managing limited water supplies, and preventing a course that leads to possible conflict over water. Countries like Morocco need to be

[256] Ibid.

[257] Ibid.

[258] Campbell, ed., *Climatic Cataclysm,* 66. The 4.7 degrees F is based on climate projection models from the 2000 IPCC assessment being too low in their estimates. Estimates by scientist A. Barrie Pittock factor in recent events such as an increase in melting of the Antarctic and Greenland ice shelves and changes in global wind patterns, see Climate Progress, "Are Scientists Underestimating Climate Change," ClimateProgress.Org, climateprogress.org/wp-content/uploads /2007/08/pittock.pdf, (accessed June 23, 2009)

[259] Ibid.,, 103-107, 141

innovative in managing their limited water resources, as in the future climate change which is forecasted to bring about prolonged droughts, will further decrease supplies.[260]

The thesis will now shift to the Middle East, which will also show how internal and external water issues will affect regional stability. Lack of stability in these regions has security implications for the United States, as conflicts may affect the availability of oil in the region, and terrorist organizations stand to gain from the instability by influencing the local populations.

**THE MIDDLE EAST**

**Map 3-4 The Middle East**

261

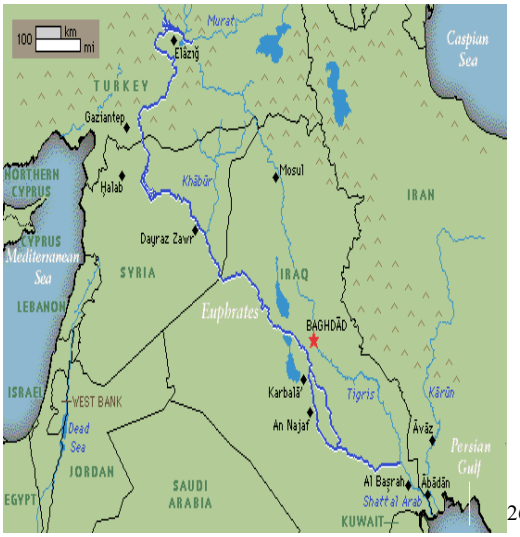
[260] Linda Starke, ed. 2009 State of the World Into a Warming World: A Worldwatch Institute Report on Progress Toward a Sustainable Society New York: W.W. Norton & Company, 2009, 44

[261] Fisher and Askari, "Optimal Water Management in the Middle East and Other Regions,"

**Turkey**

The Tigris and Euphrates rivers begin in Turkey, and link the interests of Turkey, Syria, Iran, and Iraq. Turkey is the one country in the region that does not depend on water resources outside its borders, thus Turkey's water resources should not be affected by climate change for the next 30 years. Turkey is able to negotiate from a position of strength, whereas everyone else is vulnerable to distribution. This study assesses that Turkey may negotiate from a position of strength, but they are a potential target if the water scarcity situation ever became critical.[262]

**Maps 3-5 and 3-6 The Euphrates and Tigris Rivers**



263

264

Turkey has created the South East Anatolia project, which consists of 22 dams, 19 power plants, and reservoirs on the Tigris and Euphrates rivers. The project, which

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[262] Campbell, ed., *Climatic Cataclysm*, 105-6

[263] Encarta, "Euphrates River," http://encarta.msn.com/media_461520444_761555291_-1_1/euphrates_river.html, (accessed April113, 2009)

[264] Encarta, "Tigris River," http://encarta.msn.com/media_461545977_761574188_-1_1/Tigris_River.html, (accessed April 13, 2009)

should be completed by 2010, may be good for Turkey, but it deprives Syria and Iraq of fundamental water supplies. Iraq depends on both rivers, but without a three way agreement, it has to survive on whatever water Turkey and Syria does not take.[265]

Turkey's Attaturk dam, which was complete in 1992, blocks the Euphrates River. It carries "328 cubic meters of water each second out of Attaturk's reservoirs to 1.5 million acres around the Horron plain."[266] The intent is to create enough irrigated land to make up 64% of the country's land mass, as of 2002 only 4% of Turkey's land was irrigated. The intent of the project is to add roads, railroads, telecommunications lines, clean drinking water, sewage treatment plants, and fertile land for agriculture, which will come at the expense of Iraq and Syria. The project will cost Syria 50% of its Euphrates water, and Iraq 90%. Syria is looking into its own projects, which would reduce Iraq's water supply even further. One of Turkey's officials was quoted as saying: "In the coming decades in the Middle East, the most important resource will be water and we are the richest possessors of water in the region."[267] The attitude of "every country for itself" increases the potential for conflict. Cooperative measures would allow for an investment in shared projects. This would benefit multiple countries, rather than each country investing in smaller projects, which further diminishes water availability. Cooperative measures would also allow for a better assessment of shared water tables.

The Turkish government believes that all the dams and irrigation systems that form the South East Anatolla project would generate enough water and electricity to

[265] Ward, *Water Wars,* 189-194

[266] Ibid., 190

[267] Ibid., 189-192

support an area the size of Belgium, Holland, Luxembourg and Turkey combined. [268] Turkey understands that the implications from climate change could result in decreased agriculture production, as climate change will lead to increased temperatures, longer summers, and less water runoff. Turkey expects to use economic resources to fight erosion in the Aegean, Mediterranean, and Black Seas. It has also partnered with various organizations to study the current and future effects from climate change.[269] It is important for each country to understand the impact of climate change on their water supply, and be proactive in addressing the issue. If a country does not work with its neighboring countries to seek equitable solutions, tensions will only escalate.

**Syria**

Syria and Iraq have had issues over water in the past such as in 1975 they almost went to war when Syria built a dam which denied Iraq 25% of its water flow. As Syria's reservoirs filled up, it refused to negotiate with Iraq, as it believed it was still giving an adequate amount to Iraq; both sides massed troops on their borders. Saudi Arabia and the former Soviet Union had to step in to prevent a full scale war.[270] The lack of a water treaty between nations makes the possibility of conflict over water more likely. Without a water agreement, a country is free to pursue its own water projects that will benefit only its citizens, and may decrease the amount of water available to its neighbors. If

[268] Ibid., 191

[269] Environmental News Service, "Turkey Moves to Address Climate Change," entry posted February 15, 2007, http://www.ens-newswire.com/ens/feb2007/2007-02-16-03.asp, (accessed May 21, 2009); United Nations, "Convention to Combat Desertification," entry posted April 2001, http://www.unccd.int/cop/officialdocs/cop4/pdf/ ahwg4add1eng.pdf, (accessed May 21, 2009)

[270] Ward, *Water Wars*, 192

construction begins without its neighbor's approval, it risks an attack as its neighbor's way of life may be at stake. Due to Turkey's SE Anatolla Project, Syria has started its own water projects, which will deplete some of the water ways that went into Iraq. Syria's and Iraq's support for the Kurdish separatists in Turkey may be due in part to Turkey's water policy, thus water issues are an instigator for a proxy war.[271] Water is interwoven into the peace negotiations in the Middle East. It is believed that "because Syria is so affected by its relations with Turkey, it can't possibly come to a satisfactory water relationship with Jordan and Israel."[272] Syria wants permanent access to the water resources from the Sea of Galilee that are located in the Golan Heights. This is a further complication in the ongoing border negotiations with Israel.[273] It is possible that without agreements with either Turkey or Iraq, Syria's growing population could exceed the limited supply, but Syria is exploring other options, such as a proposal with Iran. In March 2009, Iran and Syria agreed to improve cooperation concerning water resources.[274]

Rising temperatures and changing precipitation patterns have already had an effect on Syria as the 2008 drought can be attributed to climate change. Livestock farmers were affected as there was less barley to feed the animals. As droughts in Syria become more frequent and intense, the government will be forced to import food products such as rice and wheat. The challenge for the government will be to keep food

[271] Ward, *Water War*, 192-93

[272] Ward, *Water Wars,* 194

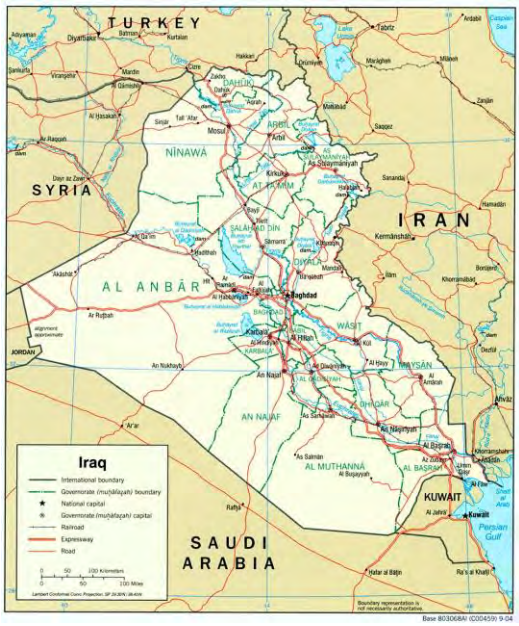
[273] Campbell, ed., *Climatic Cataclysm*, 105-6

[274] United Press International, "Emerging Threats: Iran, Syria talk water," UPI.com, http://www.upi.com/Emerging_Threats/2009/03/23/Iran-Syria-talk-water/UPI-56451237838007/, (accessed June 23, 2009)

products at an affordable price to support its population, as it deals with various factors besides drought, such as government debt and changing oil revenues.[275]

## Iraq

### Map 3-7 Iraq



276

Parts of Iraq have been suffering through a severe drought since 2007, which has negatively affected both its agriculture and fishing economies. The area affected most is the 8,000 square miles that make up the marshes created by the Tigris and Euphrates rivers in southern Iraq. After the 1991 Gulf War, Saddam Hussein had the marshes dried by building dams to punish the Shiites in the marsh area, who he considered disloyal. After the US invasion, the United Nations created an $11 million project to revive the

[275] IRIN, "Syria: Bread subsidies under threat as drought hits wheat production," entry posted June 30, 2008, http://www.irinnews.org/Report.aspx?ReportId=79006 (accessed May21, 2009)

[276] Ted Thornton, Northfield Mount Hermon School, "Histroy of the Middle East Database," entry posted 2004, http://www.lib.utexas.edu/maps/middle_east_and_asia/iraq_pol_2004.jpg (accessed May 21, 2009)

marshes, and by 2006 50% of the marshlands had flooded. However, with the ongoing drought, the levels of the Tigris and Euphrates have dropped, causing the marshlands to dry up. Again, during the past two years Iraq, Syria and southeast Turkey have received only 30-40% of their normal rainfall.[277]

Iraq's water issues are compounded by pollution and climate change. The Tigris River is filled with contaminated oil, sewage, industrial waste, plastic, and other toxins, which along with the decreased water levels due to Turkey's dams and reservoirs and decreased precipitation have had a negative effect on the agricultures and fishing industries.[278] The 2008 drought further diminished Iraq's water resources, and Turkey has promised to double the amount of water to Iraq from the Tigris and Euphrates in 2009. Observers need to pay attention to how future water distribution plays out during periods of drought, as tensions will only increase if Iraq and Syria feel they are being treated unfairly. Climate change, which may spur prolonged droughts, could make this scenario more frequent in the future.[279] The projections of prolonged droughts in the region are based on findings by the IPCC, which are based on past observations and estimations on increased carbon emissions.[280]

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[277] Associated Press, "Iraq drought hits marshes in 'Garden of Eden' 'We have lost everything and our situation is miserable,' fisherman says," entry posted April 15, 2009, http://www.msnbc.msn.com/id/30227029/ wid=18298287, (accessed April 15, 2009)

[278] Inter Press Service, "Water Crisis Hits Iraq," entry posted April 14, 2009, http://www.huffingtonpost .com/2009 /02/12/water-crisis-hits-iraq_n_166517.html (accessed May 22, 2009)

[279] Michael van der Galien, "Turkey promises Iraq double water supply," PoliGazette, entry posted March 25, 2009, http://www.poligazette.com/2009/03/25/turkey-promises-iraq-double-water-supply/ (accessed May 22, 2009)

[280] The IPCC uses factors such as demographic, economic and technological factors to project how greenhouse gases will affect climate change. The IPCC projects with high confidence that the droughts for the region will increase in intensity. Increased atmospheric temperatures will affect precipitation patterns.

Iraq is in a weak position, due to being the downstream recipient of the water from the Tigris and Euphrates. It depends on an adequate amount of water from both rivers, especially the Euphrates, to support its needs, particularly agriculture. All three countries, Turkey, Syria, and Iraq, are working on various irrigation schemes, along with increasing need for more water for urban and industrial purposes. The combined population of all three countries is expected to increase by 88 million over the next 50 years, placing more demand on the water basin.[281] Every water project in Syria or Turkey will cause increased friction with Iraq, and there is no guarantee these disputes will be settled peacefully. There is a desperate need for a distribution plan to be developed and agreed upon by all three countries for the Tigris and Euphrates Rivers, but so far there has been little or no progress in this direction.[282]

Iraq understands how a water treaty could resolve their water issues before a crisis occurs, and that a future conflict over water would not solve anything. In August 2007, Iraq's water resources minister publicly pleaded for a water agreement with Syria and Turkey to no avail. Ideally, Iraq would be aware of the current and future projects in Syria and Turkey, and a treaty would allocate how much water Iraq would receive. This would limit the scope and size of the water projects. As stated earlier, in 2009 Turkey agreed to double the water supply to its neighbors, but it is under no legal obligation to do so. A formal treaty would decrease the chances of conflict.[283]

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[281] Klare, *Resource Wars*, 181

[282] Ibid., 173-182

[283] Pete Harrison, "Iraq calls for water treaty to avert crisis," Environmental News Network, http://www.enn.com/top_stories/article/22217, (accessed June 23, 2009)

## Iran

### Map 3-8 Iran


284

Iran is home to six main fresh water basins: 1. The Lake Orumieh basin in Northwest Iran; 2. The Gulf of Oman and the Persian Gulf basin which runs from Southwest to Southeast Iran; 3. The central basin in the middle of Iran; 4. The Hamoun Basin in the East; 5. The Sarakis Basin in Northeast Iran and; 6. The Caspian Sea basin in Northern Iran; so water scarcity is less of an issue. The Caspian Sea basin receives the largest amount of rainfall at 430mm yearly and the Sarakis basin receives the least at 90mm a year, which causes an unequal distribution of water to the population.[285] The Karun River, the country's largest river originates in the Bakhtiairi Mountains, in south central Iran, and travels 515 miles westward to the Shatt al-Arab River, which is also where the Tigris and Euphrates flow into.[286]

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[284] Narvanarra: Committed to Environmental Issues, "Iran's Water Basins," http://www.narvanarra.com / environment/core_env.htm, (accessed April 16, 2009)

[285] Ibid.,

[286] Britannica Online Encyclopedia, "Karun River," http://www.britannica.com/EBchecked/topic /312778/Karun-River (accessed April 16, 2009)

Even with these water assets, Iran still suffers from water problems. "It is estimated that by 2025 Iran will suffer serious environmental degradation unless adequate environmental management is applied."[287] Iran ranks seventh in the world with over ten million hectares of cultivated land under irrigation, but it has 8 million hectares which are subjected to dry farming.[288] In the areas used for dry farming Iran uses qanats, which are man made underground channels that move water from the base of mountains to cropland near villages, although they are expensive to build and maintain.[289] Iran's water issues include: desertification; wetland losses from drought; soil degradation (salinization), inadequate supplies of potable water; water pollution from raw sewage and industrial waste; and the need to provide clean water to a growing population.[290] Urban development, insecticides, and cooling water for atomic energy plants, along with large hydropower facilities and larger agricultural areas, have increased the pollution and lowered the flow in Iran's rivers. Iran is in need of legislation to deal with water pollution.[291]

In 2003, the Narvan Arra enterprise, an Iranian environmental and industrial firm, started the first River Water Quality Monitoring Network in Iran. They initiated four

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[287] Narvanarra, "Iran's Water Basins"

[288] Dry Farming is a type of farming practiced in arid areas without irrigation by planting drought-resistant crops and maintaining a fine surface tilth or mulch that protects the natural moisture of the soil from evaporation. http://www.ask.com/web?q=dictionary%3A+dry+farming&content= ahdict% 7C19 597&o=0&l=dir, (accessed April 16, 2009)

[289] United States Library of Congress Country Studies, "Iran-Water," http://countrystudies.us/iran/74.htm, (accessed May 27, 2009)

[290] CIA- The World Fact Book, "Iran," entry posted April 9, 2009, https://www.cia.gov/library/publications/the-world-factbook/geos/ir.html#Issues, (accessed April 16, 2009)

[291] Narvanarra, "Iran's Water Basins," http://countrystudies.us/iran/74.htm, (accessed May 27, 2009)

field stations along the Karun and Dez Rivers to provide data about the flow and level of the rivers, as well as the quality of the water, to allow the government to make smart water management decisions. Unfortunately, this system does not solve the growing demand on Iran's water resources.[292] For Iran to better manage its water resources and to achieve long term water security, amidst the impacts of climate change and population growth, the country needs to understand how much water it has. From an environmental security perspective, Iran's knowledge of its water supplies allows the international community to better assist Iran with solutions. If Iran is better able to manage its water, it will lessen the security implications for its neighbors, and indirectly for the United States.

Iran's growing population and its demands on the water resources is cause for concern. "Iran, a country of 70 million people, is over-pumping aquifers by an average of 5 billion tons of water per year, the water equivalent of 1/3 of its annual grain harvest."[293] Villages in eastern Iran are being abandoned as wells go dry, generating a flow of internal "water refugees".[294] Internal migration and how it affects Iran is a concern for the United States, due to Iran's aggressive nature. North East Iran is agriculturally rich, but its water tables are falling by 2.8 meters a year as of the late 1990s. Climate Change will add to Iran's water issues, as Iran depends on snowmelt from the Alborz Mountains during the dry seasons. [295] As Iran's demand for water increases, its management of its water has various issues, such as poor quality, increases

[292] Ibid.

[293] Brown, *Plan B 2.0,* 45-46

[294] Ibid., 47, 67

[295] Ibid., 47

in costs for supplying more water, worsening pollution, exploitation of underground water, and the need to conserve the water during periods of drought. Agriculture comprises one third of Iran's economy, and in 2001 accounted for 92.8% of all water consumption.[296] With overuse of its water supplies and a forecast for even less resupply, Iran needs to plan for and prevent future water issues before they become too severe. This includes containing population growth and solving the unequal distribution of the population. As will be shown, Iran's water issues are not as critical as Lebanon's, which has to negotiate with four different countries to achieve water security.

**Lebanon**

The Jordan River originates in Lebanon at Mount Hermon. The Hasbani River, which originates in Lebanon, the Dan River which originates in Israel, the Yarmouk River which originates in Syria, and the Baniyas River, which originates in Israel, all combine to form the Jordan River. It is heavy with salinity. In addition, the 140km long Litani River starts and finishes within Lebanon. The rising populations in Lebanon, Israel, and Jordan put enormous demands on the rivers. The combined population of the three countries in 1950 was 3.9 million; in 2050 it is expected to rise to 31 million.[297] Since they are all facing the same problem, if the three countries and the Palestinian territories undertook cooperative measures and combined resources such as technology and funding, they could better prepare for the pending water crisis. Funds could be pooled to build desalinization plants and undertake better water conservation measures.

[296] Kaveh Madani Larijani, *Iran's Water Crisis; Inducers, Challenges, and Counter-Measures*, Netherlands: European Regional Science Association, 2005

[297] Klare, *Resource Wars* 157-172

Water management in Lebanon is a challenge as data about Lebanon's water resources is difficult to obtain, is of poor quality, and may be non-existent. The lack of data makes it difficult for Lebanon to manage its water resources properly for both current and future planning, and for international organizations to assist Lebanon with its issues. Research has shown that the domestic, agricultural, and industrial sectors of Lebanon consumed over twice the amount of water in the 1990s as they did in the 1960s, and 50% of that comes from aquifers.[298] Another issue for Lebanon is the quality of water as a large number of factories may be harming the water supply. Researchers believe that Lebanon needs to update and expand its water infrastructure to reduce loss and improve delivery; improve the skills of the staff; more efficiently manage its limited funds; update and or produce detailed hydrological maps; and install drainage to regions that are at risk for salinization.[299]

In Lebanon water scarcity is critical enough that families have to have water pumped to their house twice a week; there is barley enough for cooking and sanitation. The 2006 war between Israel and Hezbollah damaged Lebanon's already ageing water infrastructure. UNICEF has been working with the government to rebuild the water systems, reduce the population's dependence on pumping wells, and establish chlorination stations to improve the drinking water.[300]

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[298] Hussein A. Amery, "Chapter 2. Assessing Lebanon's Water Balance," The International Development and Research Center, entry posted October 1998, http://www.idrc.ca/en/ev-33225-201-1-DO_TOPIC.html, (accessed May 27, 2009)

[299] Ibid.

[300] Serene Assir, "At a glance: Lebanon: Rehabilitating water systems and raising hygiene awareness in south Lebanon", entry posted February 2007, http://www.unicef.org/infobycountry/lebanon_38335.html, (accessed April 17, 2009)

Climate Change may contribute to internal strife within Lebanon between Shia Muslims and Christians**,** over decreasing arable land in the Bekka Valley. The Muslims receive their irrigation water from the Orghosh springs, where the Christians live. The Christians say it is not just their use of the spring water that is decreasing the amount going to the Muslims, but a lack of precipitation. This prevents the Muslims from receiving needed water supplies. Either way the loss of arable land, caused by inefficient irrigation techniques, will only get worse as Lebanon's population is projected to grow from four million to seven million by 2025.[301] In addition, the temperature is expected to increase 1.7 $^{C}$, which will counter the fact that Lebanon receives the highest amount of rainfall in the Middle East.[302] Tensions already exist in this region due to religion, culture, and historical events; climate change will only increase the already existing tensions, or commensally could provide an opening for cooperation.

Climate Change will have an adverse affect on Lebanon's limited water supply. "In Lebanon, net annual usable water resources would likely decrease by 15 percent, in response to an average temperature rise of 1.2 degrees C. River flows are likely to increase in winter and decrease in spring, which would negatively affect existing uses of river water."[303] Predictions show that average temperatures would increase more in the winter, resulting in less groundwater recharge for the spring, with "higher future temperatures that will increase evapo-transpiration and changes in climate patterns that

[301] Integrated Regional Information Networks, "Lebanon: Climate change and politics threaten water wars in Bekka," United Nations Office for the Coordination of Humanitarian Affairs, entry posted February 1, 2009, http://irinnews.org/Report.aspx?ReportId=82682, (accessed May 27, 2009)

[302] Ibid.

[303] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030,* 15

might reduce rainfall."[304] Higher temperatures which result in higher evaporation rates will cause an increase in demand for irrigation water. Heavier precipitation periods would increase runoff further reducing water resources. This is a frightening scenario, considering Lebanon's current water scarcity issues.[305]

**Israel & Palestine**

Water issues with Israel and its neighbors have been ongoing since Israel's birth as a state. Former Prime Minister Ariel Sharon stated: "People generally regard 5 June 1967 as the day the Six Day War began…That is the official date. But in reality, it started two-and-a-half years earlier, on the day Israel decided to act against the diversion of the Jordan {River}."[306] During the six day war, Israel blew up the Syrian dam on the Yarmouk River. "By reserving most of the West Bank's underground water supply for its own use and that of Jewish settlers, Israel has created a blatantly unequal situation in the area with Jewish settlers receiving five to eight times more water than the Palestinians."[307] Israel's control over the water resources creates a huge disparity between the Israelis and Palestinians, especially when one views green houses on Israel's side of the border, and the insufficient amount of water on Palestine's side.

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[304] Fathi Zereini and Heinz Hotzl, Climatic Changes in the Middle East and North Africa, Heidleberg: Springer-Verlag, 2008, 95-97

[305] Ibid.

[306] Quote given to the author from the environmental science faculty at the Army War College on March 13, 2009

[307] Klare, *Resource Wars*, 171

The problem of sharing water must be resolved between Israel and Palestine, before a peace agreement can be reached.[308] The way forward is that the two governments along with Lebanon and Jordan need to agree on an allocation process concerning the Jordan River. The main issues would be over equity and control.[309] Besides the Jordan River, the two factions share an underground aquifer in the Gaza Strip and three in the West Bank. The 1993 Declaration had an objective of equal distribution of water between the two countries. At present, the 3.6 million Palestinians consume 280 million cubic meters (mcm) of water a year, whereas the 6.7 million Israelis use 2,170 mcm a year.[310] The Israel/Palestine Center for Research and Information (IPCRI) believes joint management of the water resources is needed in a Permanent Status Agreement, which would include agreeing upon the annual removal in volume from each shared water resource. Fair distribution of water is needed to help reduce the threat of conflict and build trust.[311]

Israel is outgrowing its limited water supplies. Analysts John Podesta and Peter Ogden observe:

By 2025 Israel may have fewer than 500 cubic meters of water per capita per year and by over pumping its existing water sources it is contributing to the gradual depletion and salinization of vital aquifers and rivers. Much of Israel's water, moreover, is located in politically fraught territory: one third of it flows from the Golan Heights and another third is in the mountain aquifer that straddles the West Bank and Israel.[312]

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[308] Ward, *Water Wars, 205-208.*

[309] Aaron T. Wolf, *Hydropolitics Along the Jordan River: Scarce water and its impact on the Arab-Israel conflict,* Tokyo: United Nations University Press, 1995, 155-57

[310] David J.H. Phillips, "Factors Relating to the Equitable Distribution of Water in Palestine and Israel," Israel/Palestine Center for Research and Information, entry posted May 10, 2006, http://www.ipcri.org/, (accessed May 28, 2009)

[311] Ibid.

[312] Ward, *Water Wars,* 106

The implications for the United States Intelligence Community are that as Israel further depletes its limited water supplies and its population feels the effects, it will be less willing to negotiate, further increasing tensions. The Israeli Government is looking for innovative solutions to its water problems. It has had discussions with an American corporation, Bechtel, to build oil and water pipelines to Turkey. They have also reached a deal with Turkey to transport water in Medusa bags from Turkey to Israel.[313] Israel's deal with Turkey will help in the short term, but "it would not offset the added pressures of climate change and population growth."[314]

Just as Israel is over pumping the underground water, the Palestinians are doing the same thing as they are drawing on the underground water faster than it can be recharged. As climate change causes sea levels to rise, saline water will seep into the underground coastal aquifers, further decreasing the freshwater supplies in the Gaza Strip, affecting both drinking water and agriculture. [315] Irrigation and sewage water are also adding to the salinity of the aquifers, and adding harmful nitrates. Forecasters predict precipitation to decrease by 20-40%, so water management techniques such as desalination projects, advanced irrigation techniques, recycling of sewage water for irrigation, and management of spring flows into aquifers so it is not lost to the sea, are needed so the aquifers are not over pumped during periods of decreased precipitation.[316]

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[313] Ibid., 194

[314] Campbell, ed., *Climatic Cataclysm, pg 106*

[315] The Center for Naval Analysis. *National Security and the Threat of Climate Change*. pg. 30

[316] Fathi Zereini and Heinz Hotzl, Climatic Changes in the Middle East and North Africa, Heidleberg: Springer-Verlag, 2008, 145-162

Annex II of the 1994 Peace Treaty established allocations between Israel and Jordan concerning the Jordan River Basin. It stipulates the amount of water that Israel would receive from the Yarmouk and Jordan Rivers, in both summer and winter. Both countries agreed to protect the water from pollution and unauthorized withdrawals. The treaty also states that each country would exchange data concerning the river, and form a joint water committee. It will be interesting to observe if the treaty stands up during periods of drought, or if it will be tested, as was the case with the Jordan-Syria treaty.[317]

**Jordan**

The water interests of Syria, Lebanon, Jordan, Israel, and Palestine are all tied to the Jordan River. It is possible that Israel and Jordan could go to war over access to water in the future.[318] This possibility will become more likely, as the Jordan River decreases, due to climate change leading to increased droughts.

The Jordanians feel that they are not receiving their fair share of water from the Yarmouk River, due to both Israel and Syria not giving them their perceived allocation. Israel was allocated 25 mcm from the Johnston negotiations, but takes 90 mcm.[319] Jordan wants to reach an agreement with Syria over an underground aquifer that lies beneath both their countries, along with reaching agreements with both Israel and Syria. If the

[317] The Hashemite Kingdom of Jordan, "Treaty of Peace between The Hashemite Kingdom of Jordan and The State of Israel," Kinghussein.gov, http://www.kinghussein.gov.jo/peacetreaty. html, (accessed June 23, 2009)

[318] Campbell, ed., *Climatic Cataclysm,* 141

[319] Aaron T. Wolf, *Hydropolitics Along The Jordan River: Scarce water and its impact on the Arab-Israeli conflict*, Tokyo: United Nations University Press, 1995, 140, The Johnston negotiations were conducted by Eric Johnston, a special envoy from President Eisenhower from 1953-55 and resulted in the Unified or Johnston plan, although it was never ratified

agreements are ever reached, Jordan will need to build a long term water storage facility to hold the additional allocations.[320]

In 1998 Jordan and Syria did sign a water sharing agreement concerning the Yarmouk River, that allowed for the construction of the al-Windeh Dam, which was completed in 2006.[321] For a treaty to be effective, both parties must follow all the stipulations. In April 2009, Jordan accused Syria of violating the treaty, as Syria was extracting additional water for agriculture. According to the treaty, Syria is allocated 6 million cubic meters (mcm) of water when the dam reaches 110 mcm, but since the dam is only reaching 18 mcm, Syria is only receiving 1 mcm. Although Syria may be violating the agreement as a means to compensate, for drought, Jordan wants to observe the agreed upon parameters.[322]

Climate change will cause a decrease in the flows of the Yarmouk and Jordan rivers, adding more water stress to Israel and Jordan. The water shortage will threaten agricultural production. Salinization of the coastal aquifer will further reduce the yields of agriculture.[323]

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[320] Ibid

[321] Arabic News, "Syria, Jordan sign al-Yarmouk river water agreement," ArabicNews .com, http://www.arabicnews.com/ansub/Daily/Day/981124/1998112415.html, (accessed June 23, 2009)

[322] Stephen Betheil, "Jordan Says Syria Violates Water Agreement," Water Secrets Blog, enrty posted April 6, 2009, http://watersecretsblog.com/archives/2009/04/jordan_says_syr.html, (accessed June 23, 2009)

[323] The Center for Naval Analysis, *National Security and the Threat of Climate Change*. 30

**Yemen**

With a population of 21 million, Yemen is ranked 15th in the world of nations over pumping their aquifers.[324] "Yemen is one of the least developed countries in the world, and ranks 149 out of 175 countries on the UNDP Human Development Index (2004). As of 2003, it has a per capita GDP of US$520 (WDI 2005). Forty-two percent of the people live in poverty and one in five is malnourished."[325] With its poor economy, Yemen has a large amount of al-Qaeda terrorists, who have conducted suicide bombings against tourists and attacked the US Embassy in September 2008.[326] Analysts fear that Yemen will face an economic crisis as its oil reserves dry up, which could happen as early as 2017.[327]

The challenges Yemen faces concerning water are: limited natural fresh water resources; inadequate supplies of potable water; overgrazing; soil erosion; and desertification. Yemen is also subjected to various waterborne diseases, such as bacterial diarrhea, hepatitis A, and typhoid fever vectorborne diseases*:* dengue fever and malaria water contact *disease:* schistosomiasis.[328] These water issues will lead to food scarcity, and the diseases will lead to health issues; Yemen has limited funds to deal with either issue.

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[324] Brown, *Plan B 2.0,* 43. The United States is ranked 14th.

[325] The World Bank, "Yemen," entry posted August 2006, http://web.worldbank.org/ WBSITE/ EXTERNAL/COUNTRIES/MENAEXT/YEMENEXTN/0,,menuPK:310170~pagePK:141159~piPK:141110~theSitePK:310165,00.html, (accessed April 3, 2009)

[326] BBC News, "Blast rocks US embassy in Yemen," entry posted September 17, 2008, http://news.bbc.co.uk/2/hi/middle_east/7620362.stm, (accessed May 22, 2009)

[327] Martin Plaut, BBC News, "Yemen faces crisis as oil ends," entry posted November 30, 2008, http://news.bbc.co.uk/2/hi/middle_east/7739402.stm, (accessed April 13, 2009)

[328] Central Intelligence Agency: The World Fact Book, "Yemen" entry posted April 9, 2009, https://www.cia.gov/library/publications/the-world-factbook/geos/ym.html, (accessed April 13, 2009)

In west Yemen, the Sana'a Basin's annual water extraction of 224 million tons surpasses the annual recharge of 42 million tons.[329] The water table is dropping six meters per year. It is possible the Sana'a basin could be pumped dry by 2010; the area is home to around two million residents. Yemen has drilled 2 kms into the Sana'a and failed to retrieve water.[330] In the future, the government will have to relocate the capitol or pipe water from coastal desalination plants. Yemen's population is experiencing a 3% growth rate per year. They are also extracting their groundwater at an accelerated rate, which means that parts of the agricultural economy could disappear within the next 25 years.

[329] Brown, *Plan B 2.0*, 47

[330] Ibid., 48

## Bahrain & Saudi Arabia

### Map 3-9 Bahrain & Saudi Arabia

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Less than 3% of Bahrain's land (665 sq km) is arable, which is not enough to feed a population of over 700,000. The diminishment of limited arable land is due to periods of drought, and dust storms; coastal degradation from oil spills and industrial growth.[332] Bahrain relies on desalination plants as its water is filled high levels of salt. Saudi Arabia has less than 2% arable land, limited surface and groundwater reserves, low precipitation, and high evaporation, with both high population and industrial growth. The population has increased from 7.7 million in 1970 to 11.8 million in 1990, it could rise to 19 million

[331] Perry-Castaneda Library Collecrion, "Bahrain Maps," University of Texas Libraries, http://www.lib.utexas.edu/maps/middle_east.html, (accessed May 23 2009)

[332] CIA World Factbook, "Bahrain," entry posted May 14, 2009, https://www.cia.gov/library/publications/the-world-factbook/geos/ba.html, (accessed May 28, 2009)

by 2010.[333] There are over twenty aquifers, although the quality varies and only a small amount are rechargeable, and thirty-five desalination plants. Water demand has increased from 2,532 mcm in 1970 to over 30,000 mcm in 1992.[334]

The Bahrain Government is working on a mobile reverse osmosis desalination plant that will be operated by solar power. It will be able to produce 200 gallons of fresh water per day.[335] In June 2008, the government published a master plan that will cost hundreds of millions of dollars, and improve the country's water supply. They created a Water Resource Council to manage the project and plan to develop the sanitation and supply sectors. They are able to supply potable water to 100% of the population, and plan to provide sanitation coverage to 100% by 2015.[336] Their water supply comes from ground water, desalination, and treated water. Desalination is the primary source for potable water. The intent is for the desalination plants to be able to produce 200 million gallons per day by 2011, an increase over the current 143 million gallons per day.[337] Some of Bahrain's grandiose plans, such as the 2.2 billion dollar Al Dur power and water project, have been delayed past its 2011 completion date. This is because the 2008/2009 economic crisis has delayed the amount of funds moving into the Middle East region, and banks are less willing to loan the amount of funds needed, which has caused various

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[333] Walid A. Abderraham, "Water demand management in Saudi Arabia," entry posted 2001, http://www.idrc.ca/en/ev-93954-201-1-DO_TOPIC.html, (accessed May 27, 2009)

[334] Ibid., Nonrenewable water makes up almost 83% of Saudi Arabia's available water.

[335] Mohammed A. Raoof, *Climate Change: Threats, Opportunities & the GCC Countries*, The Middle East Institute Policy Brief No. 12, April 2008, 11

[336] "Bahrain unveils water master plan," entry posted July 2008, http://www.powerandwaterme.com/ images/pdf/ Bahrainunveilswatermasterplan3JulTA.pdf, (accessed April 17, 2009)

[337] Ibid.

projects to be cancelled or delayed. "The (Al Dur) plant will have power generation capacity of 1,234 megawatts, and will be able to desalinate 218,000 cubic metres of water per day."[338] As some of the Middle Eastern countries' populations and economies continue to grow, it will become more expensive to meet their water demands.

The Saudi Arabian government is working on a desalinization project that will be solar powered. It is being coordinated with the American Cooperation Program.[339] Saudi Arabia, a country of twenty-five million people, has developed an extensive irrigated agriculture, based largely on its deep fossil aquifer. Some Saudi Arabian farmers are pumping water from wells that are 4,000 feet deep, which is 4/5$^{th}$ of a mile.[340] It is believed that in 1984, Saudi Arabia's fossil water reserves contained 462 billion tons of water; estimates show that in 2006, the reserves contained half that amount. At this rate, irrigated agriculture may only last another 10-20 years.[341]

## SUMMARY

A country is considered "water stressed" when the fresh water resources per person is in the 1,000-1,600 cubic meter range. It is considered "water scarce" when it has less than 1,000 cubic meters per person, along with its withdrawals exceeding its supply by 20%. Kuwait is considered to be in the "water scarce" category, along with

[338] Eman Goma, "Credit crunch delays Bahrain's power, water projects-GIC," entry posted January 19, 2009, http://www.arabianbusiness.com/544133-credit-crunch-delays-bahrains-power-water-project, (accessed April 17, 2009)

[339] Raoof, *Climate Change,* 11

[340] Brown, *Plan B 2.0*, 47

[341] Ibid.

Jordan, Israel, and Algeria. With climate change and increasing populations, Libya, Egypt and Iran should join them in the next few decades. Water issues in this region will only worsen over time unless proper measures are taken.[342]

None of the Middle East and North Africa countries can solve their long term water issues without the assistance of other countries. Even wealthy countries like Saudi Arabia have to import more food than what they produce, due to water scarcity issues. For the sake of their citizens, these countries need to move beyond political and religious differences, to include issues of mistrust. In the absence of a water treaty, and overarching water plan, some of theses countries suffer far more than what they should or need to.

Proper water management practices need to be put in place before climate change and population growth worsen this situation. These management practices need to include equitable distribution and population controls. Countries' industrial and residential users need to be educated and involved in conservation and water pollution control measures. Management of this scarce resource is key, not only for future stability, but for survival.

Due to their oil resources, large populations, historical and religious ties, and possible links to terrorism, the Middle East and North Africa are regions of great interest for the United States Intelligence Community. Anything that can degrade the stability of the regions is a concern. Water scarcity, due to misuse and poor management including pollution and overuse, as well as climate change, with forecasts of prolonged droughts,

[342] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030,* 47

increased evaporation, and increased salinity, will affect the stability of the regions. If the countries were not overpumping the aquifers, equitably distributing existing water resources, and polluting the rivers, then perhaps the effects of climate change would not have as much of an impact. But with the current reality, the impact of climate change may eventually push a fragile situation into a crisis.

This chapter shows how a lack of water security, to include international treaties, decreasing water supplies, and mismanagement of water resources, can lead to state instability. A lack of a water treaty increases tensions between countries affecting stability. The lack of a treaty between Iraq, Syria and Turkey continues to cause mistrust between the countries. Iraq already faces internal tensions between its three ethnic groups, and increasing water scarcity only adds to these tensions. Without a water treaty for both the Nile River and the underground aquifers, tensions in North Africa over water will continue. A treaty can increase stability as was shown between Israel and Jordan. This treaty has built trust between the two nations. However, a treaty is only as good as long as it is followed, as was shown by the treaty between Syria and Jordan.

Decreasing water supplies, due to an increasing demand, were shown in Iran where overpumping of the aquifers has led to internal migrations. Yemen's Sana'a Basin and its decreasing water table could be an issue as early as 2010. Another example is the situation between Syria, Lebanon, Israel and Palestine.

Mismanagement in the form of pollution was shown in Morocco's pollution degrading the quality of its limited water supply. Pollution of the Tigris River is further decreasing Iraq's water availability. Lebanon's industrial water waste is only making their situation worse.

Climate change's impact on the water resources were shown in the increase in sea level rise affecting population displacement and agriculture production in Egypt. Climate change, which is impacting the Tigris and Euphrates rivers with prolonged droughts, further increases tensions. Another example was the 2008 drought in Syria, which impacted livestock production.

An "every country for themselves" approach is further depleting shared water resources, along with increasing tensions in the regions. Libya's depletion of the Nubian sandstone aquifer may increase tensions with its neighboring countries if they attempt a similar project. Turkey's SE Anatolla project is causing further resentment from Syria and Iraq, as their share decreases due to Turkey's control. Egypt's threats concerning the Nile, fuel tensions with countries such as Ethiopia.

The main assessment of the water situation in these regions by the author is water scarcity, due to an arid climate, is being made worse by overuse caused by population growth and poor agricultural practices. Climate change, which is causing rising sea levels and worsening droughts, will continue to compound the problem. The way forward is a comprehensive regional agreement that assesses how much water each country has, and how much each needs, along with developing conservation practices to include measures to control pollution. Population control measures and water projects that benefit all the countries, that share these resources are needed. Until a regional plan is enacted, water tables will continue to fall, and a water crisis may be unavoidable.

# CHAPTER 4

# WATER ISSUES IN LATIN AMERICA AND HOW CLIMATE CHANGE IS IMPACTING THEM

"It is also evident that countries that have bountiful water resources are facing governance challenges to provide water and sanitation services *and* protect water resources."[343]

-United Nations World Water Development Report 2, 2006

## Introduction

### Map 4-1 Latin America

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[343] Sawvel, *Water Resource Management,*, 112

[344] Perry-Castañeda Library Map Collection, the University of Texas, "Latin America," http://www.lib. utexas.edu /maps /americas/latin_america.gif, (accessed May 4, 2009)

With projected changing precipitation patterns and glacial melting, climate change will have profound affects on Latin America's water resources. Based on its emissions scenarios, the IPCC projects with high confidence that climate change will cause higher temperatures that will lead to decreased soil moisture.[345] As climate change causes sea water temperatures to rise, the amount of algae will increase, causing saline seepage inland. This phenomenon will lead to an increased amount of salt in inland waterways and subsoil.[346] Except for southern South America, Latin America will experience higher temperatures than the rest of the world.[347] Decreased precipitation will be prevalent in Central America and southern South America, specifically Argentina and Chile.[348] A predicted decrease in summer precipitation will affect tropical rain forests, which depend on a substantial amount of rain year round. With climate change, water runoff is expected to increase in Uruguay, along with the northern Andes, the east-central region of South America, and southern Brazil.[349] Agriculture in the tropics will be difficult, as there will be less fresh water for irrigation, as the water in the soil will be filled with too much salt, due to rising sea levels seeping into the inland waterways, and

[345] Intergovernmental Panel on Climate Change, "Climate Change 2007: Synthesis Report," IPCC, http://www.ipcc.ch/ipccreports/ar4-syr.htm, (accessed June 21, 2009), 50. All climate projections are based off of the four most probable carbon emissions scenarios and how the results in temperature rise will affect global climate.

[346] Ward, *Water Wars*, 20-24

[347] IPCC 4th Assessment report cited in Campbell, ed. *Climatic Cataclysm,* 71

[348] IPCC, *2007: Regional Climate Projections: In Climate Change 2007: The Physical Science Basis. Contribution of Working Group1to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* New York: Cambridge University Press, 2007, 853. Predictions for specific changes in regional climate change used the Atmospheric-Ocean General Circulation Models (AOGCM) and multi-model data sets.

[349] Campbell, ed. *Climatic Cataclysm,* 74

decreasing precipitation.[350] Soil salinization, which causes rapid evaporation of water from irrigated fields, will also be more frequent.[351] If Global Warming occurs as expected, based on carbon emissions projections leading to rising temperatures, researchers predict 10-80 million people in Latin America could suffer from water scarcity, and if the global temperature increase is severe, the number could be as high as 90-180 million people.[352]

The 2008 National Intelligence Assessment (NIA) noted that climate change will have different effects on the water issues in Latin America.

> Precipitation predictions are much less certain, and climate change may moderate water stress in some regions of Latin America by the 2020s; however, an estimated 7-77 million people would remain stressed due to non-climate related demographic and economic pressures.[353]

The assessment notes how recent increases in rainfall, along with an increase in flood frequency and intensity in southeast Brazil, Paraguay, Uruguay and a portion of Bolivia, have changed land use and crop yields. The increase in rainfall and flooding will make agriculture more challenging in these regions. At the same time, there has been a decrease in precipitation in parts of Chile, Argentina, Peru and Central America. Agricultural producers will have to adapt to the changes, and may even have to change

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[350] Ibid., 850, 892

[351] Eiichi Shimojimaa, "Salinization owing to evaporation from bare-soil surfaces and its influences on the evaporation," Science Direct.com, http://www.sciencedirect.com/science ?_ob= ArticleURL&_udi=B6V6C-3VW297J-17&_user=10&_rdoc=1&_fmt=&_orig=search &_sort=d&_ docanchor =&view =c&_searchStrId=939201007&_rerunOrigin=google& _acct=C000050221 & _version =1&_urlVersion=0&_userid=10&md5=fe9ce621b3620e48d04be229e7aae459, (accessed June 24, 2009). The increased salt in the soil moisture destroys plants as their cells are unable to retrieve water thus the loss of plant life leads to an increase in evaporation.

[352] Campbell, *Climatic Cataclysm,* 65

[353] The National Intelligence Council. *National Intelligence Assessment. National Security Implications of Global Climate Change to 2030.* 14

the crops they grow based on precipitation levels. Due to changing precipitation patterns, climate change will negatively impact the region's agricultural exports. The NIA is also concerned about how climate change will affect the stability in certain countries in Latin America, as it will aggravate social tensions between the rich and poor, and there may be limited water available and unequal distribution. Organizations such as the World Water Council, the United Nations Environment Programme, and the Global Water Partnership can predict the pending crisis, but the water distribution issues need to be resolved, at the same time climate change is addressed. The report puts Chile, Bolivia, Argentina, Paraguay, and Guatemala in an elevated vulnerability status, due to their coping capacity.[354]

Runoff from mountain glaciers supplies water for drinking, agriculture, and hydropower for electricity. Millions of people in South America depend on glacier melt for their water needs.[355] As glaciers shrink from global warming over the next few decades, there will be less water runoff to meet the populations' needs and could lead to emigration. There are limits as to what can be done to address the issue, as climate change is projected to cause temperatures to rise even more in mid and high altitudes.[356]

Leonardo Martinez-Diaz, a political economy fellow at the Brookings Institution, notes that: "Climate Change potentially threatens Central American and Caribbean nations with destruction and dislocation."[357] This researcher observes the need for

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[354] Ibid., 14, 49

[355] Campbell, *Climatic Cataclysm,* 65

[356] Ibid.,, 68

[357] Leonardo Martinez-Diaz, *Latin America: Coming of Age,* World Policy Journal, Fall 2008, 221-227

continued aid from the United States, especially humanitarian relief and reconstruction resources, if climate change causes more intense and destructive hurricanes and severe storms. He further mentions other changes for Latin America in the next 25 years, such as an aging population, economic competition with China and India, and an expanding middle class, which makes dealing with the problems brought on by Climate Change more challenging. Based on the current economic crisis, how much financial aid can the United States contribute to fix the problem and where will the priority be?[358]

> The National Intelligence Council notes in its report Global Trends 2025:
>
> Demand for water for agriculture purposes and hydroelectric power generation also will expand. Use of water for irrigation is far greater than household consumption. In developing countries, agriculture currently consumes 70% of the world's water.[359]

Poverty, dependence on water for agriculture and hydropower for electricity, all play a part in Latin American countries. Higher temperatures caused by global warming, will cause accelerated evaporation from water bodies, along with an increased need for water by vegetation, which will mean that there is less water available for stream flow and ground recharge.[360] Researchers believe that climate change will cause crop yields to decrease at lower latitudes and increase at mid and higher altitudes. This could lead to

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[358] Ibid., 221-227

[359] National Intelligence Council, *Global Trends 2025: A Transformed World*, 51

[360] Sawvel, ed. *Water Resource Management,* 11-31. Researchers predict changing precipitations for Latin America which will affect agriculture production. Climate models show a decrease in precipitation across Central America, thus the concern over migrations into the U.S. see Intergovernmental Panel on Climate Change. *2007: Regional Climate Projections: In Climate Change 2007: The Physical Science Basis. Contribution of Working Group1to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* New York: Cambridge University Press, 2007, 850, 894

migrations within Latin America, as the eventual increase in sea level, along with severe droughts, and storms become more frequent.[361]

Latin America is very dependent on the environment for the populations' livelihood, and the region has dealt with some intense environmental problems in recent decades. The deforestation of the world's tropical rain forests, which is believed to be about 13.6 million hectares per year, is adding 6.5 million tons of CO2 to the atmosphere each year.[362] South America is close behind Africa in the rate of the region's deforestation. Latin America is third behind Africa and Asia, as a region that has suffered through the largest number of droughts in recent decades, and is second behind Asia with the largest number of floods.[363] In Latin America, the droughts affected 48 million people and floods affected 40 million people from 1975-2001.[364] Water scarcity, along with land degradation, deforestation, droughts, floods, storms, and famine, may intensify as climate change progresses.[365]

Researcher Fred Pearce notes: "South America has only 5% of the world's population, but glories in three of the world's top ten rivers- the Amazon, the Orinoco, and the Parana."[366] Still, one-fifth of the population (49.4 million) of Latin America

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[361] Campbell, *Climatic Cataclysm*, 98-99

[362] Starke, 2009 *State of the World Into a Warming World:*, 7

[363] Ragnhild Nordias and Nils Peter Gleditsch, eds., "Climate Change and Conflict," Political Geofraphy, August 2007, 661

[364] Ibid.

[365] Ibid., 627-673

[366] Pearce, *When the Rivers Run Dry,* 22-23

lacks access to drinkable water.[367] As the United Nations Development Programme (UNDP) notes: "The scarcity at the heart of the global water crisis is rooted in power, poverty and inequality, not in physical availability."[368] The UNDP believes in most countries the issue is not a case of water availability, but in how the government institutions distribute the water.[369]

Although the percentage of people with direct access to water has increased from 33 percent in 1960 to 85 percent by 2000, there are still 77 million people without direct access to water in their residences in Latin America. The 51 million rural and 26 million urban residents can not afford to have water connections installed.[370] Approximately 256 million people rely on latrines and septic tanks, as only 40% of the population is connected to sanitation services.[371] Another issue is the pricing inequality between the poor and the rich, as the poor pay between 1.5 and 2.8 times as much for water.[372] Financial constraints force countries in Latin America to make difficult choices between water uses, such as industrial, agricultural, and residential use. An example of the effect of limited finances, only a small portion of the sewage from households goes to a sewage treatment plant; the rest flows directly into rivers, lakes, and underground aquifers.

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[367] Nordias and Gleditsch, eds., *Climate Change and Conflict*, pg. 661 and Sawvel, ed. *Water Resource Management*, 40

[368] United Nations Development Programme, "Beyond Scarcity: Power, Poverty and the Global Water Crisis," Humane Development Report, 2006, 10-12, quoted in Sawvel, ed. *Water Resource Management,* 32

[369] Ibid., 33

[370] The World Water Council 4th World Water Forum, "Water Problems in Latin America," entry posted 2006, http://www.worldwatercouncil.org/fileadmin/wwc/News/WWC_News/water _problems _22.03.04.pdf, (accessed May 5, 2009)

[371] Ibid.

[372] Ibid.

Pollution from over-mining and agriculture affects the majority of underground aquifers. The national security concern for the United States is that as clean fresh water is further depleted due to pollution, countries will become more unstable as their economies suffer. Pollution will degrade the agriculture and fishing industries that so many residents depend on, along with increasing the spread of diseases. [373]

An example of a shared aquifer that could be affected by pollution is the Guarani aquifer, which covers an area of 400,000 square miles underneath Brazil, Argentina, Uruguay, and Paraguay. New research shows that it could contain 40 billion acre-feet of water, and rainfall continues to refill it. Researchers believe it could supply up to 200 million people with adequate water supplies.[374] The Guarani aquifer could solve Latin America's water issues, or it could be mismanaged as much of the region's vast water resources are today. The United States could strengthen ties with Latin America by offering technical advice on pollution control measures, as well as the most efficient ways of extracting water from the Guarani aquifer. The advantage for the United States in offering this assistance is that the abundance of water and the effective conservation measures would help bring long term sustainment to the region. In 2008, Brazil was the sixth largest exporter of goods to the United States and Argentina was the 13th largest exporter. The long term sustainment would protect the United States economy.[375]

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[373] Ibid.

[374] Pearce, *When the Rivers Run Dry*, 59

[375] United States Department of Agriculture Economic Research Service, "Top 15 U.S. import sources by fiscal year," United States Department of Agriculture, http://www.ers.usda.gov /Data/FATUS/, (accessed July 7, 2009)

**Mexico**

Mexico, already an arid region, is experiencing water scarcity due to mismanagement, including a water treaty with the United States concerning the Colorado River that is unfavorable to Mexican farmers, along with over-pumping its underground aquifers, a growing population, and climate change. The mismanagement is also due to overuse, poor irrigation practices, and contamination of its limited water resources. Mismanagement occurs mostly in water scarce areas, where the majority of the population resides.[376] Climate change will likely cause more water issues and lead to more migrations as it is projected to cause prolonged droughts. According to researcher Kurt M. Campbell:

> In Mexico, climate change likely will mean more mass migration from central lowlands to higher ground. Immigration from Guatemala and Honduras into southern Mexico (whether for employment in Mexico or passage to the U.S.) is already a major issue for the Mexican government and will intensify dramatically.[377]

Climate Change is expected to impact northern Mexico with more frequent and longer lasting droughts, and a monsoon season that is expected to bring less precipitation.[378] The NIA states that "Mexico is projected to be one of the world's hardest-hit countries for water scarcity for demographic in addition to climatic reasons."[379] Trying to manage climatic change effects such as droughts can be difficult, as it is difficult to predict

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[376] Douglas Olson and Gustavo Saltiel, *Chapter 9: Water Resources-Averting a Crisis in Mexico in Mexico 2006-2012:Creating the Foundations for Equitable Growth,* The World Bank, Mexico: Horacio Press, 2007

[377] Campbell, ed. *Climatic Cataclysm,* 137

[378] Ibid., 66

[379] The National Intelligence Council. *National Intelligence Analysis. National Security Implications of Global Climate Change to 2030,* 30

beyond one or two seasons, and water resource managers of large reservoir systems need decade long predictions for proper planning purposes.[380]

A rapidly growing population, which is currently at 107 million, could reach 140 million by 2050.[381] That is causing the country to over pump its underground aquifers and drain its lakes and reservoirs. Researcher Lester R. Brown notes:

> In the agricultural state of Guanajuato, the water table is falling by 2 meters or more a year. Lake Chapala, the country's largest, is the primary source of water for Guadalajara, which is home to 5 million people. Expanding irrigation in the region has water volume in the lake by 80 percent.[382]

This scenario could force the region to decrease agriculture production, as the water needs of the urban population will come before the needs of the farmers and the rural population.[383] The rural and native populations of the river system that supports Mexico City are upset with how the water projects have destroyed their water and their land. Mexico City depends on the Cutzamala system, which consists of the Cutzamala, Lerma, Temascaltepec, and the Balsas rivers. Some of the dams built on the rivers are located 130 kilometers from Mexico City. The purification systems have contaminated the rural population's rivers with harmful chemicals, and faulty hydroelectric systems have flooded the farmland.[384] The native population wants the government to enforce their

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[380] Sawvel, *Water Resource Management,* 29

[381] Brown, *Plan B 2.0*, 48,

[382] Brown, *Plan B 2.0*, 48, 52, Guadalajara is Mexico's next largest city

[383] The urban populations and farmers are sharing the same water resource, and the country would rather import more food than force their city residents to undergo increased water stress.

[384] Verdicts from Public Hearing Regional, Mexico Latinoamerican Water Tribunal, "Case Water basin deviation form the Cutzamala region to the Valley of Mexico," entry posted March 2006, http://www.tragua.com /tca_tla/pdf_tla/VeredictosPrimeraAudiencia/ING_CasoCutzamalaMazahuas.pdf, (accessed May 7, 2009)

general plan for sustainable development, and believes that the water deviation projects from their region to Mexico City are unsustainable.[385]

Mexico City is growing increasingly reliant on over-pumping its underground reservoirs.[386] As of April 2009, the city is experiencing some of its worst water shortages. The city has been forced to ration water from its reservoir due to the ongoing drought, and is hoping for a rainy summer to bring the reservoir levels back up to their normal levels. The government recognizes the need to overhaul their fresh water system. The current crisis has caused sanitation issues, as households do not have running water for toilets, showers, and cooking. Mexico City sits in an area that used to be a lake, and as the city over-pumps the aquifers, it is sinking at almost three inches a year.[387] This sinking puts pressure on water pipes, which lose almost 40% of water from leaks before they reach households.[388] The recent water crisis occurred as the government needed to put stoppages in the reservoir, to allow the Cutzamala system to refill it. Decreased rainfall which may be caused by climate change has caused the main reservoir to be at only 47% capacity.[389] Overuse is another cause, as Mexican city residents use 300 liters of water per person, compared to the average European city which averages 180 liters per day.[390]

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[385] Ibid.

[386] Pearce, *When the Rivers Run Dry*, 58

[387] Ioan Grillo, "Dry Taps in Mexico City: A Water Crisis Gets Worse," entry posted April 11, 2009, http://www.time.com/time/world/article/0,8599,1890623,00.html?xid=rss-world, (accessed May 5, 2009) 1-3

[388] Ibid., 2

[389] Ibid

[390] Ibid.

In 2006 the World Water Council reported:

> In Mexico, 102 of the nation's 653 aquifers are overused, the main source of water for 65 percent of the population. In some areas, farmers have had to switch from water-intensive cotton to less profitable grain crops used to feed cattle, because the aquifers no longer produced sufficient water to grow cotton.[391]

The major aquifer that supports the Chihuahua dessert is depleting at a rapid rate due to overuse. Canals are being built in El Paso along the Rio Grande to capture the water, so that it never makes it into the ground to supply the aquifer. By the time the river reaches Juarez it is not even a stream, and is coated with small amounts of sewage and salt cedar. Because of actions by the United States, it is even more difficult for Mexico to produce agriculture. [392] Due to the lack of water, farmers in the region find it difficult to grow corn and cotton. Water is made more scarce for farming due to large dams and irrigation projects, which were intended for cotton farming, and have destroyed the soil along with filling it with salt. Farmers have turned to cattle farming; for feed they use alfalfa, which also demands a lot of water to feed their cattle. Dairy farmers need over 2000 gallons of water for irrigation to produce one gallon of milk.[393] Due to increasing water scarcity caused by actions taken by both the United States and Mexico, Mexico's ability to support its citizens with agriculture will become more of a challenge, and affect the country's stability.

In the Yaqui River Valley, the farmers' demand has exceeded the supply of the river. Due to irrigation use, the reservoirs have dried up and farmers are leaving the

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[391] The World Water Council 4th World Water Forum, "Water Problems in Latin America," entry posted 2006, http://www.worldwatercouncil.org/fileadmin/wwc/News/WWC_ News/water_problems _22.03.04.pdf, (accessed May 5, 2009)

[392] Salt Cedar is a shrub and a single shrub can absorb 256 gallons of water a day

[393] Pearce, *When the Rivers Run Dry*, 15-16

area.[394] It is believed that 90% of the water Mexico takes from the environment is used for irrigation. The city of Juarez has to use treated sewage water to irrigate its crops, as the region is so short of water, and has a limited amount of desalination plants.[395]

Mexico receives limited amounts of water from the Colorado River due to the western United States' growing population and climate change further limiting their fresh water resources. In March 2008, a study was released that showed that the western United States is warming twice as fast as the rest of the world, and the area will face drought conditions in its growing large cities.[396] The Colorado River is warming at twice the rate of the global average.[397] The Rocky Mountain Climate Organization has taken measurements that show the river is 2.2 degrees hotter than the average for the 20th century.[398] The Intergovernmental Panel on Climate Change estimates that with a 2.0-2.5 Celsius increase in the world's temperature, the Colorado River could be reduced to unprecedented levels. These could not be compensated for by an increase in water reservoir capacities or operating policies for water supplies, decreasing the amount that flows into Mexico. The national security implications for the United States are that as climate change further decreases the amount of water flowing into Mexico, the country will become even more stressed, forcing people to migrate to the United States.[399]

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[394] Ibid., 24

[395] Ibid., 12-24

[396] Science Daily News, "America West Heating Nearly Twice As Fast As Rest of World, New Analysis Shows," entry posted March 30, 2008 http://www.sciencedaily.com/releases /2008/03/08032 8091347.htm, (accessed May 5, 2009)

[397] Ibid.

[398] Ibid.

[399] Sawvel, *Water Resource Management,* 26-29

A growing population further is depleting the Colorado River. "More than half the people who now live in the West depend on water from the Colorado river, which before it runs its course has been drained dry."[400] The United States uses around 95% of the water from the Colorado River.[401] The 1922 Colorado River treaty granted 7.5 million acre feet of water each to Colorado, New Mexico, Utah, Wyoming, Arizona, California and Nevada, and only 1.5 million acre feet to Mexico.[402] The Colorado River Basin in Mexico used to supply an abundance of water for fisherman and farmers; now it is a poverty stricken wasteland. As researchers Alexander Cockburn and Jeffrey St. Claire state: "Just before the Colorado crosses the US/Mexico border 75 percent of its flow is diverted into the All American canal. The water that eventually makes it to Mexico-much of it run-off from Arizona and California alfalfa and cotton fields—is nearly as salt laden and toxic as that in the Salton Sea."[403] Some environmentalists want to take down the Glen Canyon Dam on Lake Powell, to allow water to flow to the Sea of Cortez and replenish the Colorado River.[404]

The United States and Mexico signed a water treaty in 1944, which states that 1/3 of the water that flows into the Rio Grande (see map 4-2) from six Mexican tributaries needs to be sent back to the United States.[405] The treaty does not factor in extended

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[400] Ward, *Water Wars*, 72

[401] Alexander Cockburn and Jeffrey St. Clair, "To the Last Drop: Why the Colorado River Doesn't Meet the Sea," Counter Punch: America's Best Political Newsletter, entry posted March 14, 2001, http://www.counterpunch.org/colorado.html, (accessed June 2, 2009)

[402] Pearce, *When the Rivers Run Dry*, 196

[403] Cockburn and St. Clair, "To the Last Drop: Why the Colorado River Doesn't Meet the Sea,"

[404] Ibid.

[405] Patrick Daize, "Storage and Flood Operations in the Rio Grande Basin," entry posted October 29, 2008, http://www.ibwc.state.gov/Files/CF_LRG_Fld_Cndtns_102908.pdf, (accessed May 5, 2009)

droughts, changing agricultural needs, and growing populations. The United States can drain the Rio Grande before it reaches Mexico, but Mexico is required to give the United States an annual average of 350,000 acre feet of water over a five year period or 1,750,000 feet. Once the capacity of the Amistad and Falcon dams, are filled, then a new five year cycle starts.[406] The United States is giving Mexico $130 million dollars to line the canals near the Rios Conchos River, which feeds into the Rio Grande. Nearby rural farmers have dug 130 ft wells to use underground water, which is obtained from seepage in the canals; once the canals are lined, the rural farmers will be out of water.[407]

**Map 4-2 The Rio Grande**

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[406] Ibid.

[407] Pearce, *When the Rivers Run Dry,* 17

[408] MSN Encarta, "Map of Rio Grande (river), North America," entry posted 2009, http://encarta.msn.com/ map_701516008/Rio_Grande_(river).html (accessed May 5, 2009)

## Belize

### Map 4-3 Belize


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In 1999, the Belize government approved the Chalillo Project, an internal project which will not affect its neighboring countries, will include a hydroelectric dam in the Mecal River Valley. The project is being built by the Belize Electricity Ltd which is owned by Fortis Inc, a Canadian energy company, and will cost over $44 million. The project will provide the Moller dam generator with water during the dry season, and give the country an internal source of electricity. However, it will destroy over twelve miles of tropical forest. The Chalillo dam may also reduce and contaminate the water available to the local population.[410]

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[409] Perry-Castañeda Library Map Collection, the University of Texas, "Belize Maps," entry posted 2003, http://www.lib.utexas.edu/maps/americas/belize_rel_03.jpg, (accessed June 2, 2009)

[410] Kelly Loverock, "Chalillo chill: critics slam the dam that a Canadian company want to build in Belize's valley of the scarlet macaw," entry posted Spring 2002, http://proquest.umi.com/pqdweb?index =0& did=6325180 21& SrchMode=1&sid=1&Fmt=3&VInst= PROD&VType= PQD&RQT= 309&V Name=PQD&TS=1241726791 &clientId=39495, (accessed May 7, 2009)

Belize and other Caribbean nations will be adversely affected by climate change, as it will cause the sea level to increase, which will cause saltwater intrusion into the country's freshwater aquifers. Coastal flooding, erosion, and an increase in droughts and floods, will further diminish the freshwater supply. The erosion and an increase in the frequency and intensity of tropical storms will cause runoff off pollutants into the water systems. An increase in Belize's temperatures may lead to more water borne diseases.[411] The implications for the United States are an increased demand for humanitarian assistance and the potential for migrations to occur.

The Belize government is concerned with how climate change predictions for higher temperatures and changing precipitation will affect its food security and the health of its population. Decreased precipitation will affect the country's main food staples; bananas, citrus, sugar, beans, corn and rice depend on an ample supply of water. An increase in air and water temperature could leave the country vulnerable to diseases such as malaria, cholera, and respiratory illnesses. The country is also partnering with the United Nations Development Programme to develop both a national water plan and a strategy for its water sector to adapt to climate change.[412]

Belize and Mexico have formed a bi-national commission to resolve border concerns. The two countries also formed the Belize and Mexico international water boundaries commission (IWBC) to deal with the Rio Hondo Water Basin. In a 2005 meeting, they signed a treaty referred to as Act II of the Belize-Mexico IWBC. This

[411] The San Pedro Sun, "Global Warming-How does it affect Belize?" entry posted July 26, 2007, http://sanpedrosun.net/old/07-291.html, (accessed May 7, 2009)

[412] Belize Government National Climate Change Committee, "Government of Belize Adaptation to Global Climate Change" entry posted 2000, http://www.hydromet.gov.bz/Government %20of%20 Belize%20 Policy%20on%20Adaptation%20to%20Global%20Climate%20Change %20Draft.doc, (accessed May 7, 2009)

treaty will involve a joint effort to assess the sustainability of the water basin between 2005 and 2025.[413]

**Venezuela**

In Venezuela, 80% of the population lives along the coast where the water is polluted; and less than 25% of used water is treated before it goes back to the environment. Despite an abundance of rivers and streams, certain areas face water shortages, as they do not conserve water.[414] The government charges a house full of people the same amount for water as a single person living in an apartment, so there is no monetary incentive to conserve water. The government dumps the sewage water into open pits, which seep back into underground water supplies.[415]

As climate change intensifies, Venezuela, along with Ecuador, Bolivia, Paraguay, Peru, and Brazil, will be some of the hardest hit nations with severe droughts and floods.[416] Climate Change could bring about an increase in rainfall to Venezuela, which could lead to an increase in water-borne diseases. Populations living along the coast could experience more frequent storms and flooding.[417]

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[413] Government of Belize Ministry of Foreign Affairs, "V Meeting of the Belize-Mexico Bi-National Commission- Final Declaration, Belize Government," http://www.governmentofbelize.gov. bz /press_release_details.php?pr_id=3638, (accessed June 24, 2009)

[414] Jeroen Kuiper, "Venezuela's Environment Under Stress," entry posted March 2005, http://www. venezuelanalysis.com/analysis/973, (accessed May 7, 2009)

[415] Ibid.

[416] World Wildlife Federation, "Cross-border cooperation along the Amazon's Orinoco River," entry posted February 3, 2009, http://www.panda.org/es/sala_redaccion/proyectos/index.cfm ?uProjectID=9L0725, (accessed May 7, 2009)

[417] Campbell, *Climatic Cataclysm*, 109,

The World Wildlife Federation (WWF) is concerned with how agriculture runoff, pollution from mining, urban growth and deforestation are destroying the environment around the Orinoco River basin (see map 4-4). It is also concerned about erosion, due to 64% of the Llanos forests being deforested in the past fifty years. The organization is trying to strengthen cooperation between Venezuela and Columbia, by developing an environmental strategy for the river basin supported by both governments. A deadline for formalizing this strategy has not been set, as the countries have not made it a priority.[418]

In 1978 Venezuela signed the Treaty For Amazonian Cooperation, which included Bolivia, Brazil, Columbia, Ecuador, Guyana, Peru, and Suriname. The treaty is concerned with socioeconomic development and environmental conservation. The treaty's goals are to have cooperative efforts towards development of the region, to include equitable distribution of the benefits to improve the standard of living for all their citizens. Cooperative measures, such as this treaty, improve the chances of long term sustainability and lessen the concerns for U.S. national security.[419]

[418] World Wildlife Federation, "Cross-border cooperation along the Amazon's Orinoco River," entry posted February 3, 2009, http://www.panda.org/es/sala_redaccion/proyectos/index.cfm ?uProjectID =9L0725, (accessed May 7, 2009)

[419] Oregon State University: Program in Water Conflict Management and Transformation, "Treaty for Amazonian Cooperation," Oregon State University College of Science, http://ocid.nacse. org /tfdd/treaties.php?page=full&origin=river&TN=161, (accessed June 24, 2009)

**Map 4-4 Oronoco River Basin**

[420]

**Columbia**

Columbia is rated second in Latin America and seventh in the world in annual freshwater resources by the United Nations Food and Agriculture Organization. Therefore, its water issues are rooted in management rather than scarcity. Mismanagement is due to corruption, which has caused the price of water to be disproportionate. According to researcher Danilo Urrea: "privatization has significantly driven up the cost of water services, and the granting of concessions to private operators has also given rise to scandals and corruption."[421] The citizens of Barranquilla, Colombia pay over five dollars per cubic meter of water, compared to New York City residents who

[420] South America Travel, " Orinoco River Map," http://gosouthamerica.about.com /cs/vengeog /l/blOrinocomap.htm, (accessed June 2, 2009)

[421] Helda Martinez, "Columbia Campaign seeks to make water a constitutional right," Upside Down World: Covering Politics and Activism in Latin America, http://upsidedownworld.org /main/content/ view/869/1/, (accessed July 7, 2009)

pay less than one dollar per cubic meter.[422] By privatization of the water systems in Cartagena, Columbia allowed the amount of people receiving piped water to increase to 27%, although by 2007 38% of the population did not have access to clean water. This led to the government taking control of the water system.[423] The impact of the government having control is that it should allow the majority of the people to receive sanitized water, and that there is a long term management plan for all the water resources. There is no guarantee that the majority of citizens will receive water, as government officials can be just as corrupt as private corruptions, but fair elections should solve the problem.

There are almost sixty organizations in Columbia which are fighting for a constitutional amendment that would make access to water a right for all citizens.[424] As of 2008, 12 million of the country's 42 million people do not have access to clean water, and another 4 million have limited access.[425] Researchers believe that by 2025, 69% of Columbian citizens will have limited access to clean water, and blame the privatization of the water systems. This prediction is based on the expectation that private companies will continue to raise the price of water, and continue dumping chemicals into the Magdalena and Bogota rivers. The citizens believe that the private companies are corrupt, and have mismanaged the system. Columbians pay over five times as much for water as citizens from New York City.[426]

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[422] Sawvel, *Water Resource Management, 48*

[423] Ibid., 42

[424] Ibid., 46

[425] Ibid., 42-50

[426] Ibid.

Other issues relating to Columbia' water are pollution and instability. Columbian rebels attack the water reservoirs on a frequent basis, which makes it a challenge for the local citizens to have reliable access to water. The Bogota River, which is a tributary for the Magdalena River, is a dumping ground for chemicals from tanneries and the cut flower industry.[427] Pollution has caused the amount of fish caught in the Magdalena River to drop by 90% in the past forty years. Efforts need to be taken by the Columbian government to implement and enforce pollution control measures, along with dealing with the Columbian rebels.[428] Pollution, unequal distribution of water, and attacks by rebels on the water infrastructure, makes Columbia's water situation fragile. The projected impacts from climate change, such as rising sea levels, changing precipitation patterns and an increase in severe storms, will only increase the potential for instability and mass migrations.

**Ecuador**

Despite having over 2,000 rivers and streams, and being known as the "water capital" of the world, Ecuador is suffering through a water crisis.[429] Ecuador does not have a national policy to promote integrated water resource management. Due to overlapping institutional roles, it is unclear who is responsible for water management,

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[427] Ibid., 49

[428] Ibid., 42-50

[429] Matt Terry, "Ecuador's Water Crisis: Damning the Water Capital of the World," entry posted December 15, 2007, http://internationalrivers.org/en/latin-america/ecuadors-water-crisis-damming-water-capital-world, accessed May 7, 2009

thus the last assessment of the water resources was conducted in 1989.[430] The country is in need of modern water monitoring, to evaluate the flow of the rivers, as the various projects have exceeded the amount of available fresh water. Due to this mismanagement drinking water systems have lost up to 65% of their water resources, and only 15% of water from irrigation systems reaches its destination.[431] In addition some of Ecuador's current and proposed water projects have caused protests due to their inefficiency. An unstable Ecuador could lead to internal conflict and potential migrations to the U.S. Efforts taken by the United Nations Development Program to assist in Ecuador in developing effective long term water management strategies are critical as the country's water resources are most vulnerable to the climate change risks such as receding glaciers, intense storms and prolonged droughts.[432]

The Ecuadorian government wants to build 226 new hydroelectric projects to compensate for increased energy needs, reduce its dependency on fuel imports for thermal generators, and decrease its green house gas emissions. Previously constructed dams have been oversized, destructive to the environment, and been unable to produce the expected energy. Planned hydro projects have not involved public input, which has resulted in various protests. The Ecuadorian Rivers Institute has recommended

[430] United Nations Development Programme, "Climate Country Profile: Ecuador-Adaption to Climate Change through Effective Governance in Ecuador," United Nations, www.adaptationlearning.net /downloads /CP_Ecuador.pdf, (accessed June 24, 2009)

[431] Matt Terry, "Ecuador's Water Crisis: Damning the Water Capital of the World," entry posted December 15, 2007, http://internationalrivers.org/en/latin-america/ecuadors-water-crisis-damming-water-capital-world, accessed May 7, 2009

[432] United Nations Development Programme, "Climate Country Profile: Ecuador-Adaption to Climate Change through Effective Governance in Ecuador," United Nations, www.adaptationlearning.net /downloads /CP_Ecuador.pdf, (accessed June 24, 2009)

geothermal power, wind energy, and small micro hydro projects, rather than construction of large inefficient dams.[433]

The Guangopolo hydroelectric plant in Quito has not had enough water to produce energy in recent years. It is believed that in the past thirty years, the region has lost 40 to 50 percent of the water that comes through the plant.[434] Ecuador's drinking water, agricultural sector, and electrical grid, are all threatened by climate change, which is causing rising temperatures to eliminate the glaciers, and droughts which reduce the available rainfall. It is believed that glaciers below 17,000 feet will disappear over the next few decades, leaving rural populations without needed water supplies. This will eventually affect major cities as well.[435]

In 2005, Ecuador suffered its worst drought in 40 years, which caused annual rains to start three months late. The late rainy season caused a deficit at the Paute hydroelectric plant. The changing precipitation makes it difficult for farmers to decide when to plant their crops, and they have observed that the rainy season is producing less rain. The 2005 drought cut agriculture production by 35%, and the country lost $35 million, both domestically and through exports.[436]

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[433] Matt Terry, "Ecuador's Water Crisis: Damning the Water Capital of the World," entry posted December 15, 2007, http://internationalrivers.org/en/latin-america/ecuadors-water-crisis-damming-water-capital-world, accessed May 7, 2009

[434] Pauline Bartolone, "When the water runs out: Ecuador's crops, its power grid and the drinking water for its largest city are all threatened by climate change," entry posted April 6, 2007, http://www.salon.com/news/feature /2006/04/07/ecuador2/, (accessed May 7, 2009)

[435] Ibid.

[436] Ibid.

**Peru**

In some cases, public water systems provide water to the wealthy and middle classes, but not to the poor. In Lima, Peru, the poor pay seventeen times as much for water as the citizens who have water running to their residences.[437] Arguments have been made as to whether privatization, which involves a contract to manage public water systems on a long term lease, or government provided water, is the best system to meet the needs of the population at an affordable price.[438] The potential for instability due to a lack of water security is a concern for the United States, due to Peru's location and its vast mineral resources.

According to journalist Daniel Glick:

> Peru's Quelccaya ice cap is the largest in the tropics. If it continues to melt at its current rate-contracting more than 600 feet a year in some places-it will be gone by 2100, leaving thousands who rely on its water for drinking and electricity high, dry and in the dark.[439]

The glacier not only supplies basic needs, but also agriculture and hydropower demands. Glacier researcher, Lonnie Thompson from Ohio State University, found that the Quelccaya ice cap is retreating at ten times the rate it did during the fifteen year period of 1963 to 1978.[440] He also found that the current rate of warming at high elevations has not occurred in the past 2,000 years, and the rate of the glacier melt has not occurred in the past 5,200 years.[441]

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[437] Sawvel, *Water Resource Management,* 41

[438] Ibid.

[439] Daniel Glick, "The Big Thaw," National Geographic," September 2004, 14

[440] Sawvel, ed. *Water Resource Management*, 17

[441] Ibid.

The National Science Foundation, along with National Geographic and NASA, are supporting research on the receding glaciers, conducted by three United States universities and Peruvian researchers in the Cordillera Blanca mountain range, which is in the Ancash Region of Peru. Peru, along with other countries in the tropical region, is dependent on stream runoff from the glaciers to get through the dry season; without the glacier discharge, the populations are highly vulnerable. They have observed that the glaciers have decreased in size anywhere from 11 to 30% in the past forty years, and glacier discharges will continue to decrease in the upcoming decades, with effects on water availability being felt as early as 2030.[442] The researchers are investigating how the region's populations' livelihoods, to include their economy and social structure, are vulnerable to water scarcity. The research is expected to be completed in 2010, will show the rate of the climate induced global recession and its affect on the population. It will also provide recommendations to assist the local populations and their political institutions in adapting to the environmental changes caused by global warming.[443] The US Intelligence Community should be concerned about how the melting glaciers are affecting Peru's agriculture sector. Peru is the third largest exporter of fresh or frozen vegetables to the United States, and the fifth largest exporter of prepared or preserved vegetables. From October 2008 to April 2009, the United States spent $232 million on

[442] Jeffrey Bury, "Adapting to Uncertain Futures: A Report on New Glacier Recession and Livelihood Vulnerability Research in the Peruvian Andes," entry posted August 2008, http://proquest.umi.com/pqdweb?index= 0&did=1624441961&SrchMode, (accessed Jun 5, 2009)

[443] Sawvel, *Water Resource Management,* 17-18

Peru's vegetable exports.[444] A reduction of vegetable imports from Peru will affect U.S. markets.

**Brazil**

The Brazilian government is constantly scanning the Amazon basin for new dam sites. Brazil has at least twenty-one hydropower dams; one dam called the Sergio Motto, once flooded 556,000 acres of land. "When a dense jungle is flooded, the rotting vegetation creates methane gas, twenty times more potent than carbon dioxide."[445] Another dam, the Balbina Dam, flooded 236 sq km of jungle, but produces only 50% of the electricity needed for the population of the town of Manaus. The Balbina Dam generates more green house gases than a coal burning plant that produces the same amount of energy.[446] "Marco Aurelio, of Cidade University in Rio, says that up to half of Brazil's hydroelectric reservoirs warm the planet more than an equivalent fossil-fuel power plant."[447] Another issue with reservoirs such as Balbina, is that a third of the water is lost to evaporation, while the reservoir is loaded with mosquitoes and other disease spreading insects. Hydroelectric resources and deforestation contribute to make Brazil the eighth largest emitter of greenhouse gases in the world.[448] To prevent climate change

[444] United States Department of Agriculture Economic Research Service, "Foreign Agriculture Trade of the United States (FATUS): Top 10 sources of U.S. imports of fruits and vegetables by value," USDA.gov, http://www.ers.usda.gov/Data/FATUS/, (accessed June 26, 2009)

[445] Ward, *Water Wars*., 156

[446] Ibid., 156

[447] Pearce, *When the Rivers Run Dry,* 143

[448] Emilo Lebre La Rovere and Andre Santos Pereira, "Brazil and climate change: a country profile," Science and Development Network, http://www.scidev.net/en/policy-briefs/brazil-climate-change-a-country-profile.html, (accessed June 26, 2009)

from having severe implications which includes depleting water tables leading to food shortages, the United States needs to encourage other countries such as Brazil to reduce their greenhouse gas emissions.

The latest report by the Intergovernmental Panel on Climate Change mentions that semi-arid regions such as North East Brazil will suffer from fewer water resources due to climate change.[449] It is also projected that the Amazon rainforest will become drier, and will result in the extinction of various plant and animal species.[450] Climate Change will cause an increase in tropical freshwater temperatures, which will contribute to the loss of plant and animal life along with increasing CO2 output. The water quality in Brazil's reservoirs will decrease as higher temperatures cause a decrease in oxygen levels.[451] This scenario is further intensified by a predicted increase in deforestation. Deforestation promotes flooding and land degradation, along with reducing the amount of freshwater in the ground since there are fewer roots to help absorb the water.[452]

Brazil's Itaipu Dam, on the Parana River, is the world's largest hydroelectric facility, and at a cost of 18.5 million dollars is the most expensive project next to China's Three Gorges Dam.[453] The Itaipu Dam produces as much electricity as thirteen nuclear plants, and saves Brazil almost 350,000 barrels of oil a day.[454] The Itaipu hydroelectric

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[449] Campbell, *Climatic Cataclysm*, 72

[450] Campbell, *Climatic Cataclysm*, 75

[451] Andreas Fischlin andGuy F. Midgley, IPCC "Ecosystems, their properties, goods and services," entry posted http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter4.pdf (accessed May 20, 2009)

[452] Sawvel, *Water Resource Management,* XII, 16 Nordias and Gleditsch, "Climate Change and Conflict," 660, and Starke, *State of the World*, 7

[453] Ward, *Water Wars,* 155

[454] Ward, *Water Wars,*156-7

facility is on part of the Parana River that borders with Paraguay; in 1973 the Itaipu Accord was signed by both countries and resulted in an equal sharing of the electrical output. Such deals could be models for future water agreements.[455]

**Argentina, Paraguay, Bolivia, Uruguay**

In the 1970s, Argentina and Paraguay signed the Yacyreta Treaty, which called for a hydroelectric project downstream from the Itaipu Dam that would include thirty generators, each with a 135 megawatt capacity.[456] Argentina wanted the project with Paraguay, as it felt threatened by Brazil's influence over Paraguay. After spending almost four billion dollars, the two countries were unable to obtain a three billion dollar loan from the World Bank, and the project was never completed.[457] Efforts to combine resources between Argentina and Paraguay are encouraging, but future projects need to be environmental friendly and cost efficient. Small hydroelectric dams may be more efficient in their electrical production. Trust and cooperation between Argentina and Brazil has improved in recent years. In December 2005, they launched the Argentinean-Brazilian Biotechnology Centre; one of their projects is a more efficient water filtration system.[458] The United States needs to encourage countries to work together on environmental issues, to lessen the potential impacts from climate change.

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[455] Elhance, *Hydropolitics in the Third World*, 25-52

[456] Ibid., 45

[457] Ibid., 45-47

[458] Carla Almeida, "Brazil and Argentina launch joint nanotech centre," Science and Development Network, http://www.scidev.net/en/news/brazil-and-argentina-launch-joint-nanotech-centre.html, (accessed June 26, 2009)

Cochabamba Bolivia is an example of the issues with privatization. "Between 1989 and 1999, the proportion of households connected to the public water system fell from 70 percent to 60 percent."[459] A revolt against the Bechtel Corporation was led by the middle class, who were receiving subsidized water; the middle class and wealthy had to pay an increase of 43-60% for piped water. Privatization may have been an advantage for the poorest 5%, who would have only spent 5.4% of their total income on water.[460] These protests caused the water system to be turned back over to the government, which is only providing water for four hours a day. The poor have to pay ten times as much as those that have piped water. As a result, in 2004 Uruguay became the first nation in the world to pass a constitutional amendment which makes water a public good, and banned privatization of water and sewage systems. For a country to have internal stability, it does not matter whether the water systems are privatized or government controlled. What is important is that the water is distributed in an equitable manner, at affordable prices, and the system is free from corruption. [461]

In 2006, Argentina began having an issue with Uruguay over a proposed pulp mill project in Uruguay that pollutes the Uruguay River that is shared by both countries. The World Bank approved over $500 million for the pulp mill after conducting a study that found emissions would be well under acceptable levels. Uruguay believes the protest by Argentina has cost the country over $200 million in trade and tourism [462] Argentina and

[459] Sawvel, *Water Resource Management*, 42

[460] Ibid., 42-43

[461] Ibid., 49-50

[462] BBC News, "Argentina-Uruguay dispute deepens," entry posted November 24, 2006, http://news.bbc.co.uk/2/hi/americas/6179994.stm, (accessed May 6, 2009)

Uruguay signed a treaty that governed the utilization of the Uruguay River in 1961; that treaty recognizes that provisions would be undertaken to avoid pollution of the waters.[463] Based on the treaty, Argentina believes that Uruguay needs their permission to build the plants, but since they do not violate accepted emissions levels Uruguay disagrees. The emissions assessment should have been done by a company that was approved by both countries. The challenges with such treaties are that each country may interpret the wording differently, and if they cannot come to a resolution, then the matter should be settled in an international court.

[463] Oregon State University: Program in Water Conflict Management and Transformation "Treaty between the Argentine Republic and the Eastern Republic of Uruguay on the boundary constituted by the Uruguay River, Singed at Montevideo on 7 April 1961," Oregon State University College of Science, http://ocid.nacse.org/tfdd/tfdddocs/343ENG.htm, (accessed June 26, 2009)

**Parana-La Plata River Basin**

**Map 4-5 Parana-La Plata River Basin**

[464]

The Parana-La Plata River Basin is shared by five countries: Argentina, Bolivia, Brazil, Paraguay, and Uruguay. In a region with an abundance of freshwater, a large minority lack access to safe drinking water.[465] This minority includes 14% of Brazil's population, 25% of Bolivia's population, 27% of Argentina's population and 21% of Paraguay's population. As of 2000, the combined population of the countries was about 233 million.[466]

All of the countries in the basin are burdened with large debts, and most of the debts were acquired through large hydroelectric projects they each built in the basin. All five nations need to be able to work together by sharing the waterways, and developing water projects that will benefit all five nations. As researcher Arun P. Elhance notes, all

[464] Len Milich, "Openness and river basin institutions: Plata River basin map," entry posted fall 1998, http: //ag. arizona. edu/OALS/ALN/aln44/aln44gifs/milich7.gif (accessed May 5th 2009)

[465] Arun P. Elhance, Hydropolitics in the Third World: Conflict and Cooperation in International River Basins, Washington DC: United States Institute of Peace, 1999, 25-32

[466] Ibid., 32

the countries have similar interests; "which include ensuring the freedom and the development of riverine navigation, building reservoir capacity for multiple uses, and addressing the environmental concerns and problems raised by large water projects."[467]

The issue becomes how well the countries can resolve their issues, which include border and territory disputes. Uruguay was created as a result of territorial disputes between Argentina and Brazil; there are still border issues between Argentina and Uruguay, Brazil and Paraguay, and Brazil and Uruguay. The La Plata Basin Treaty was signed by all five countries in 1969, and encourages regional cooperation. A 1983, external evaluation declared the treaty to be unsuccessful, as only 28 out of the 167 resolutions approved by the countries had been implemented.[468]

The La Plata Basin Treaty has acted as a foundation and has allowed Argentina, Bolivia, Brazil, Paraguay, and Uruguay to improve their cooperative efforts concerning the river basins. The five countries have discussed the Hidrovia Project, which would connect 2,110 miles of the Paraguay and Parana rivers into shipping canals. Various organizations oppose the project, as it would destroy a large number of wetlands, so the countries are working with the United Nations and various NGOs to find workable solutions. Based on shared interests, such as maintaining their borders, keeping countries outside of the region from manipulating the region to their advantage, freedom of navigation on the river, and the desired economic and hydrologic growth from the rivers, the countries have established closer political ties over the water issues.[469] Future water

[467] Ibid, 33

[468] Ibid., 40

[469] Ibid., 48-51

projects that benefit multiple countries are a wise investment, but there needs to be a balance between cost efficiency, environmental concerns, and meeting the needs of the majority of the population.

**Chile**

Currently 94% of the citizens of Chile receive water, compared to 27% in 1970.[470] The cities purchase water from farmers who have adopted water saving techniques, such as irrigation technology, so they can still have sufficient water left over to sell. In 1981, Chile adopted a system of water rights which is independent of land, and that can be sold, traded, or allocated at prices regulated by the market.[471]

At the University of Chile in El Tofo, researchers have designed fog traps which consist of polypropylene nets that are able collect moisture. A 40x13ft fog trap is able to collect 45 gallons of water a day. Fifty traps are able to collect six gallons as day for each of the four hundred citizens of El Tofo.[472]

## SUMMARY

For a region with an abundance of fresh water, mismanagement in the forms of unequal distribution, misuse of limited funds, overuse in certain locations, and wasteful pollution have had severe implications for the population. Climate Change and a

[470] Ward, Water Wars, 228

[471] Ibid., 228

[472] Ibid.,10

growing population are only adding to the problem. Realistic solutions need to be put in place, before events such as Mexico City's water shutdown, become more of a common occurrence. The question, as to why Latin America, with an abundance of fresh water from its large rivers, faces water shortages has been answered, in the form of unequal distribution due to corruption which involves overpricing, and in some cases pollution and a lack or water conservation measures as shown with Venezuela.

Due to its proximity, agriculture, and oil exports, and the potential for migrations northward, Latin America is an area of interest to the United States. Similar to the Middle East, water scarcity is caused by man in instances involving pollution, overuse, and unequal distribution. Climate change is also impacting that resource due to droughts, sea level causing increased salinity in the fresh water ways, flooding, and glacier melt and may affect the stability of the region in the future. Cooperative measures between countries allow for a basis on which to adapt to climate change, but issues dealing with population growth and associated deforestation, along with unequal distribution of water, and associated poverty, act as challenges to mitigating and adapting to climate change.

This Chapter has showed how water treaties can increase cooperation between nations, however they can also pose challenges if the treaties are unfair or are interpreted differently by the countries involved. The Rio Grande Treaty limits the amount of water Mexico receives; then requires the country to give water back to the United States, further diminishing Mexico's agriculture production. Even though the Uruguay River Treaty exists between Argentina and Uruguay to bolster pollution control measures, tensions exist over a mill project and whether or not it is causing water pollution. On a positive note, treaties can act as a foundation for both long term assessments and shared

projects that benefit multiple countries, as was shown by the Belize-Mexico IWBC and the La Plata-Parana River Basin Treaty. Ecuador is an example of how the lack of an internal water management policy makes it difficult for a country to assess the status of its water, and to conduct long term planning that includes climate change adaption measures.

A region where the countries are dependent on agriculture and fishing for economic security, and whose water security is fragile based on unequal distribution, will be adversely affected by climate change. Mexico's farmers are already suffering due to both overpumping of the aquifers and prolonged droughts. Columbia, which has difficulty providing sanitized water for its residents, will be adversely affected by climate change. There are also security concerns for the United States; if some of these poor and underdeveloped countries fail to provide an adequate amount of water for their citizens, migration could become a major issue.

# CHAPTER 5

# LESSONS LEARNED

"Water scarcity caused by mismanagement and a growing imbalance between supply and demand is driving us toward a tipping point in human history."[473]
-Center for Strategic and International Studies

According to United Nations Secretary General Ban Ki-moon:

> The challenge of securing safe and plentiful water for all is one of the most daunting challenges faced by the world today…Too often where we need water, we find guns instead. Population growth will make the problem worse. So will climate change. As the global economy grows, so will its thirst. Many more conflicts lie just over the horizon.[474]

Secretary Moon's comments reflect the various challenges that contribute to water scarcity. As the world's population and economy grows, so will the demand for meat; as livestock requires an abundance of grain, which needs more water than other crops. Mismanagement of water, to include overuse of limited water supplies, inefficient irrigation and over pumping of underground aquifers, along with climate change which will bring changing precipitation levels, melting glaciers, and rising sea levels, only adds to the problem.

As stated in Chapter 1, Latin America, North Africa, and the Middle East were chosen for this thesis, as the studies by the National Intelligence Council and the Center for Naval Analysis show that they will be severely impacted by climate change and its effect on their water resources. These regions also contain many developing countries,

[473] Center for Strategic and International Studies (CSIS), *Global Water Futures: Addressing Our Global Water Future*. CSIS White Paper, September 2005

[474] Ban Kai Moon, at the 2008 World Economic Forum, quoted in Bencala, Karin R. and Daebelko, Geoffrey D., "Water Wars: Obscuring Opportunities," Journal of International Affairs Volume 61, no. 2, {Spring/Summer 2008}: 21

that face a myriad of challenges, such as corruption, terrorism, drug wars, and economic troubles, which further affects their stability. The intent of this analysis was not only to show how climate change is affecting water resources, but how human actions are negatively impacting them, as seen in pollution, overpopulation, and mismanagement of resources. Water is interconnected to all facets of human life, and as water conditions worsen, the repercussions will be felt throughout society.

Water management can be an internal challenge for a country, regardless of its wealth and water stress level. Water management is even more challenging when a country does not have a good assessment of how much water it has as was shown with both Lebanon and Ecuador. There may also be competing interests for water within a country, as between environmental and industrial groups.

The argument can be made that a sovereign nation is free to do as it pleases with the water resources inside its borders, regardless of the consequences for its neighbors. The problem with this argument is that a lack of cooperation and an inequitable distribution fuels tensions, and has potential for conflict between nations. The other problem with this argument is that as each nation pursues its own projects they are further depleting the shared water resources between nations, and its effects will be felt by the future generations of all the countries. Finally, the concept of "every country for itself" does not allow for a sharing of information and ideas. These need to be shared, not only to better manage the long term sustainability of the shared resource, but so that each country can learn from the other.

Treaties, such as the agreements between Mexico and Belize, and Israel and Jordan, represent solutions to water problems. Treaties allow for equitable distribution of

water and a sharing of ideas. When there is not equitable distribution of the water and countries refuse to recognize the provisions of the treaty then there is no guarantee of cooperation. Burundi, Congo, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda do not recognize the Nile Agreement, so tensions and mistrust continue between those countries, and Sudan and Egypt. A treaty is only as good as the willingness of its signers to abide by the terms agreed to.

An inadequate supply of water is a contributing factor that could lead to poverty, instability, and has the potential to cause migration.[475] An inadequate supply of water is not a guarantee that any of these scenarios will occur. An observer can connect the dots and say Mexico's drug trade is partially related to water scarcity; as fewer citizens can profit from agriculture they are forced into the drug trade to survive. As Palestinians observe greenhouses in Israel, while they overpay for water, they become more resentful and willing to use terrorist acts against Israel. To prevent water scarcity from leading to instability and creating breeding grounds for terrorism, the United States must be proactive and work with the international community to find solutions to these water issues, before there are severe implications for security. The chapter will now focus on the similarities and differences between the three regions concerning climate change, its affect on water resources, and the lessons learned from these cases.

[475] The link between poverty and water is observed between rural farmers and the overpricing of water as the farmer will have to pay more than the wealthy in the urban areas. In September 2000 the United Nations set a goal of 2015 to decrease by 50% the amount of people who leave on less than one dollar who are unable to afford or receive safe drinking water, see David Hemson, et al, eds, Poverty and Water: Explorations of the Reciprocal Relationship, {New York: Zed Book Publishers: 2008}, 2-3

# CLIMATE CHANGE

## Similarities

As the previous chapters have shown, Climate Change is affecting all three regions in similar ways. Rising sea levels are contributing to the salinity levels on the coasts of all three regions, and specifically in the cases of Israel, Egypt, and Mexico. Israel's coastal aquifer has become so saline, that there is a need for desalinization plants to process the water coming from it. In North Africa, Egypt has had to deal with saltwater intrusions in the Nile River Basin, and Libya has had to deal with its aquifer becoming contaminated near the coast. Rising temperatures are increasing the rate of evaporation in the Middle East/North Africa, along with parts of Latin America including Mexico. This increased evaporation rate, along with decreased precipitation, has caused Mexico City's reservoir to have a diminished water supply. Changing precipitation patterns will worsen drought conditions in the Middle East/North Africa region, as well as Mexico and the Caribbean in Latin America. The changing precipitation patterns will bring more intense storms to parts of all these regions.[476]

Climate change will change precipitation patterns as it makes arid regions drier and causes other areas to have more precipitation. Rising temperatures are causing an increase in evaporation, as the atmosphere is holding water longer. One of the impacts is a decrease in the frequency of precipitation, and an increase in the intensity of

[476] The Center for Naval Analysis, *National Security and the Threat of Climate Change,* 1-63

precipitation when it does occur.[477] The rising temperatures will change global wind (atmospheric and oceanic) circulation patterns, so precipitation patterns will be different. Precipitation patterns will also be different due to the specific geography for each region. The climate is different in each region, due to the uneven distribution of solar heating. This uneven distribution, along with the fact that some regions may have more of certain natural features that reduce warming, causes changes to be different in each region. As researchers from the IPCC gain a better understanding of the factors that affect climate change in each region, they will be able to have more confidence in their projections.[478]

As researcher, Joel Bourne Jr. from National Geographic note**s**:

> Two billion people already live in the driest parts of the globe, and climate change is projected to slash yields in these regions even further. No matter how great their yield potential, plants still need water to grow. And in the not too distant future, every year could be a drought for much of the globe.[479]

More arid regions will limit the world's agriculture output, posing further challenges as they try to feed growing populations.

**Differences**

Latin America seems better able to cope with Climate Change, than the Middle East/North Africa, as the region is not as arid and its population size and growth are not as large. Another difference is that Central America is expected to receive more intense

[477] David L. Hoover, Guiling L. Wang, and Zoe G. Cardon, "Altered Precipitation patterns due to climate change: Modeling the ecological effects on a tallgrass prarie ecosystem," eco.confex. com, http://eco.confex.com/eco/2008/techprogram/P12275.HTM, (accessed June 20, 2009)

[478] Intergovernmental Panel on Climate Change. *2007: Regional Climate Projections: In Climate Change 2007: The Physical Science Basis. Contribution of Working Group1to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* New York: Cambridge University Press, 2007, 865

[479] Bourne Jr., "The End of Plenty, Special Report: The Global Food Crisis," 58

monsoons and heavy precipitation; warmer standing water will lead to more waterborne diseases. More droughts are expected in the Middle East/North Africa region, whereas parts of Latin America are expected to receive more precipitation. With an increase in droughts, the Middle East/North Africa region will experience a decrease in soil moisture. Also, due to its mountainous terrain, parts of Latin America that are dependent on glaciers for their water supply will be further impacted, as these glaciers disappear with the changing climate. Based on the projections, the world's population must take the steps needed to curb greenhouse emissions, to lessen the severity of climate change.

## SHARED WATER RESOURCES (RIVERS)

### Similarities

Rivers that cross international borders cause problems in all three regions. Lack of or poorly designed or implemented treaties are an issue for all the countries in these regions. The treaty between Mexico and the United States is a prime example; Mexico is required to give water from the Rio Grande back to the United States, even in periods of prolonged drought. A lack of a shared vision concerning rivers that cross borders means that countries are doing their own projects without regards to the consequences for the downstream recipients, the environment, and future generations. Turkey's South East Anatolla Project is a prime example of a country looking out for its own interests. Another example is along the Nile River, between Egypt, Syria, and the upstream countries. Without any treaty, there is a lack of proper planning between the countries that depend on these rivers. The lack of a treaty between Israel and all its neighbors

shows how critical a water treaty is, based on the water distribution between these countries. The treaty between Israel and Jordan is a step in the right direction as it provides an agreement on how much water each country will receive, long term sustainability planning and shared pollution control measures.

**Differences**

An upstream user of a river that crosses international boundaries taking advantage of the downstream users, is more of an issue in the Middle East than in Latin America. Some examples are Turkey's control of the Tigris and Euphrates, and how it affects Syria and Iraq; Syria and Israel's control of the Jordan River and its effects on Jordan are another. Cooperation amongst countries that share a water resource is more likely in Latin America, as there are fewer tensions between the countries, and the Latin American countries have been independent nations for almost 100 years longer than the Middle East/North Africa region. Examples of cooperation include: Columbia and Venezuela developing a strategy for the Orinoco River Basin, and Argentina, Bolivia, Brazil, Paraguay, and Uruguay signing the La Plata Basin Treaty in 1969. Regardless of the history of a region, water treaties for shared river basins are essential, so everyone receives an adequate amount of water.

## WATER MANAGEMENT

### Similarities

One of the main similarities between the Middle East, North Africa, and Central America, is the overconsumption of limited water resources, by overpumping underground aquifers and a lack of conservation measures. Chapter 4 showed that despite being in a dry climate, Mexico City uses 300 liters of water per resident per day, compared to only 180 liters for the average European City. Mexico City had an emergency shut down of the city's water usage, due to overuse and drought and the need to refill its reservoir. Chapter 4 also showed how Mexico's farmers have been affected by the overuse of the aquifers. A similar situation has been seen in Libya, which by overpumping its aquifers, along with saltwater intrusion, has led to its wheat fields being destroyed. Iran is also overpumping its aquifers by 5 billion tons a day, causing villages to be abandoned.

States in all these regions are trying to find solutions to their water crisis. Chapter 4 showed how Chile is designing fog traps to collect clean water for its mountain villages. Bahrain is using its wealth to build a solar powered desalination plant. The problem is that most of the countries do not address the real problems, which are the demands of the growing populations, the need for cooperation with neighboring countries regarding shared water resources, the need to provide dedicated funding for water conservation, and to provide industrial regulations to limit water pollution.

**Differences**

Unequal distribution of water within some of the countries in Latin America is an ongoing problem. Chapter 4 pointed out the issue of privatization versus government control of water resources, which does not seem to be an issue in the Middle East/North Africa regions, where the water is controlled by the government. The example was given of Peru, where the poor are paying seventeen times as much for water as the middle class and wealthy.[480] In Latin America, it is not only a distribution issue between the wealthy and poor residents, but between urban and rural residents. Chapter 2 showed how there are 49.4 million people in South America without access to drinking water, in a region with an abundance of fresh water.[481]

Accurate current and future planning varies within and between the regions. Bahrain is able to use its wealth to plan for projects that will cost billions of dollars to provide clean drinking and sanitation water to its entire population. Lebanon does not have the funds or any accurate reading as to its water resources. Countries, such as Ecuador and Columbia, do not have long term plans to provide water for their populations at affordable prices. Nations need to implement water management schemes to ensure every citizen has an adequate amount of water.[482] Water managers need to understand how much water they have, what it can support, and what their priorities

[480] Sawvel, *Water Resource Management,* 41

[481] Nordias and Gleditsch, eds., *Climate Change and Conflict*, pg. 661 and Sawvel, ed. *Water Resource Management*, 40

[482] The United Nations wants everyone to have at least 5.28 gallons of clean water per day per person, the United States uses 100 gallons of clean water per person per day, Sawvel, *Water Management*, 36

should be. The public needs to understand the limits of their water supplies, how important conservation is, and how harmful pollution can be.

## WATER PROJECTS

### Similarities

All these regions have countries that have pursued massive water projects, often at the expense of the environment. Libya's Great Manmade River is a prime example. As discussed in Chapter 2, the Great Manmade River is an underground man made river which transports water from the Saharian aquifer to the coast over a nine day period, across 600 miles, at a cost of over $27 billion.[483] A growing population in an arid region cannot expect to achieve long term food and water self-sufficiency. Another example is the funding of large hydroelectric dams by both Brazil and Turkey. Brazil has twenty-one hydroelectric dams; Turkey has twenty-two dams. Turkey's dams are decreasing the amount of water being sent down river to Iraq and Syria. In the case of Brazil, these dams are still unable to provide electricity to rural villagers, as it too expensive to run the needed power and electrical lines. Other problems included Brazil's Balbina Dam, which produces only 50% of the electricity needed for the city of Manaus, but produces more greenhouse gases than a coal burning plant, and the 236 square kilometers of jungle that have been flooded by the dam give off methane gas, which is more severe than carbon dioxide in its effect on the atmosphere.[484]

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[483] Pearce, *When the Rivers Run Dry,* 45-48

[484] Ward, *Water Wars*., 155-160

**Differences**

Lack of funding to pursue water projects, is an issue for all the developing countries in the regions of North Africa and Latin America, as they do not have the vast amounts of wealth as most of the countries in the Middle East. The large hydroelectric project that Argentina and Paraguay wanted as part of the Yacyreta Treaty, was dependent on funding from the World Bank; due to their massive debts, the two countries were unable to receive this funding, thus they are unable to provide needed electricity to their citizens. The project was also viewed as being inefficient, as it would have cost over $4 billion for a limited electrical output. The upstream Nile users need additional funding to pursue their desired projects, which would negatively impact the rest of Egypt. A solution to this lack of funding is that neighboring countries need to pool their resources together, and work with international water experts to come up with the most efficient solution.

The problem with large hydropower projects is that they are expensive and can destroy massive amounts of land, which causes the displacement of thousands of people, usually the poorest part of society. One solution is the use of small hydro units that are less expensive, use local materials, and do not contribute to global warming. These small water units can be placed anywhere water falls, generate a significant amount of hydropower, and are a good concept for developing countries. Another cost effective initiative is to increase the capacity of the existing dams. Brazil will add two new

turbines to the Itaipu dam to supply electricity for 1.5 million people at a cost of $185 million. A new hydropower plant would cost almost $1 billion, and would pump sulfates and CO2 into the atmosphere.[485] With limited funding, countries need to ensure the project reaches the maximum number of the population, with little destruction to the environment, is sustainable, and cost efficient.

## POPULATION GROWTH, FOOD AND WATER

### Similarities

According to the Australian Director General of the International Water Management Institute, Dr. Colin Chartres:

> We will not begin to feed the world's population in the coming decades, unless we begin to manage our water supplies better. Dr. Charles said it takes 1 litre of water to grow 1 calorie of food and as more people move to western style diets an average person will be 'consuming' 2500-3000 litres of water a day that has been used to grow their food.[486]

The growing population, with more urban dwellers and changing diets, puts more demand on the water supplies. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Water Assessment Program (WWAP):

> When 40% of renewable water resources are devoted to irrigation, countries are forced to decide between allocating water to the agricultural sector or to the urban

[485] Ward, *Water Wars,, 158-160*

[486] International Water Management Institute, "Food and water crises inextricably linked," entry posted June 19, 2008, http://www.iwmi.cgiar.org/news_room/pdf/Food_and_water_crises_inextricably_linked.pdf, (accessed June 3, 2009)

> municipal and industrial sector. By 2030, South Asia will reach that 40 percent level and the Middle East and North Africa region will have hit 58 percent.[487]

As urban populations grow in the Middle East, North Africa, and the Latin America, the goals of nations such as Libya of having food self sufficiency, becomes even more unreachable.

Tim Dyson, a professor of population studies at the London School of Economics notes: "Ultimately there has to be a balance between population and resources. And this notion that we can continue to grow forever, well it's ridiculous."[488] Chapter 3 showed that Lebanon is using twice as much water in the 1990s as it did in the 1960s, due to the growing populations' demands in the domestic, industrial, and agriculture sectors; it is difficult to see the limited water supply supporting a continual increase in demand. A similar situation is occurring in Mexico, another arid country, where the population could grow by 33 million in the next forty years.[489]

Researchers from the United Kingdom, the United States, Spain, and Austria note: "Climate change is expected to increase yields in high and mid latitudes, and lead to decreases in lower latitudes. By the 2080s, the additional number of people at risk of hunger due to climate change is about 80 million people. However, some regions (particularly the arid and sub-humid tropics) will be adversely affected."[490] Climate change may increase production in some higher elevations, but as shown in Chapter 4,

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[487] Center for Strategic and International Studies (CSIS), *Global Water Futures: Addressing Our Global Water Future*. CSIS White Paper, September 2005

[488] Joel K. Bourne Jr., "The End of Plenty, Special Report: The Global Food Crisis," National Geographic, June 2009, 58

[489] Brown, *Plan B 2.0*, 48

[490] Martin Parry et al., "Climate change and world food security: a new assessment," Global Environmental Change 9 (1999): S51

mountainous regions such as the Andes that depend on glacier runoff for agriculture production, will be adversely affected.

Agriculture, specifically irrigation practices, account for 70% of the world's water use. In both Egypt and Mexico, 90% of the water is used for irrigation. As seen in Chapter 3, Iran is seventh in the world for cultivated land under irrigation. Over irrigation has caused a loss of arable land in all three regions, as the soil becomes filled with too much salt. The depletion of underground aquifers is diminishing water supplies for farmers. Countries, such as Iran and Mexico, have been unable to track the amount of wells rural farmers have dug and how much water they have extracted from the aquifers, making water management even more difficult. Ideally, industries that are less dependent on water should be developed in these arid countries to replace the agriculture sector, which is depleting the limited water supplies.

**Differences**

There is more population growth in ME/NA than Latin America and fewer water resources to support it. Latin America's population growth is around 1.1%, whereas the Middle East/North Africa is around 1.8%, although population growth in Yemen is as high as 2.8% due to a lack of family planning education. The size of Latin America's overall population is larger than the Middle East/North Africa region, with 569 million people compared to 432 million, but it has a larger land mass to support them.[491]

There is more need for food imports (virtual water) in the Middle East and North Africa than in Latin America, although parts of Mexico will need more imports due to

[491] The United Nations, "World Population Prospects: The 2008 Revision Database," http://esa.un.org /unpp /index.asp?panel=2, (accessed June 4, 2009)

droughts. The challenge, for countries such as Syria and Mexico, is to keep the food imports at an affordable price for the populations. As their water tables diminish, to avoid importing more food, countries will be tempted to tap into a neighboring country's water supplies. A more sensible option for a country facing water scarcity issues is to be more efficient in managing the limited water supplies they have, by sanitizing the polluted water in their country and developing more efficient agriculture practices. Other options are to transport water into the country from other countries that are not facing water issues and to move people out of the country, so that the limited water supply can better meet the demand. In the future, all countries will need to put limitations on their population and encourage less meat heavy diets, so there will enough water to adequately feed all of the world's population.

## ENVIRONMENT

### Similarities

Pollution is diminishing the availability of water in all the regions, with funding needed to clean the polluted rivers. Venezuela is an example where untreated sewage is dumped into pits and allowed to seep into the ground. The Orinoco River Basin is being destroyed by erosion, mining pollution, and deforestation. Another example is Egypt, where too much irrigation has destroyed some of its crop fields. Pollution from sewage has been an issue in countries such as Syria and Iraq, which dump sewage into the Tigris and Euphrates, along with Brazil and Argentina dumping sewage into the Parana-La Plata

Basin.[492] Morocco has also contributed to pollution of water resources by dumping sewage and fertilizer into the Sebou River Basin.

Manmade reservoirs and canals have led to an increase in waterborne diseases, due to the large amount of sitting water. Examples have been shown in Egypt, with the reservoirs at the Answan and High Dams, the city of Damietta, and the Chalillo Project in Belize. Climate change has also led to an increase in diseases in all the regions, due to increasing water temperatures.[493]

Oil runoff into the fresh water supplies has been an issue in the regions. Chapter 2 gave the examples of Venezuela's oil runoff seeping into the aquifers, and oil in Iraq seeping into the Tigris River. Financially, these countries, which are dependent on oil for their wealth, need to think in the long term with regard to their water, and spend the money now to clean up their water systems before the funds are no longer available.

**Differences**

An environmental issue which affects Latin America and not the Middle East and North Africa is deforestation, as it is adding to the increase of CO2 into the atmosphere. The destruction of tropical forests in Belize due to the Chalillo Project, a $44 million hydroelectric dam, served the electrical needs of the country at the expense of the

[492] Arun P. Elhance, *Hydropolitics in the Third World: Conflict and Cooperation in International River Basins*, Washington DC: United States Institute of Peace, 1999, 29. 128-129

[493] Ward, *Water War,* 197-200, United Nations Foundation, "Water Pollution Provokes Disease," entry posted September 15, 2009, http://www.unwire.org/unwire/19990915/4806_story.asp, (accessed May 25, 2009) and Kelly Loverock, "Chalillo chill: critics slam the dam that a Canadian company want to build in Belize's valley of the scarlet macaw," entry posted Spring 2002, http://proquest.umi.com/pqdweb?index =0& did=6325180 21& SrchMode=1&sid=1&Fmt=3&VInst= PROD&VType= PQD&RQT= 309&V Name=PQD&TS=1241726791 &clientId=39495, (accessed May 7, 2009)

environment. It is estimated that 60-70% of the deforestation in Brazil is due to cattle farmers and a lack of regulation by the government.[494] Until Latin American countries place a higher value on the tropical forests, the problem will continue to get worse.

An issue that affects the Middle East and North Africa regions more than Latin America is desertification, as aquifers have been depleted and arid land has constantly been overwatered. The opposite scenario is occurring with the various dams and canals which are preventing water from reaching areas that could benefit from it. Climate change will add to the desertification, as sea level rise will cause salt to seep into the underground aquifers. Countries in all three regions need to understand how their destruction of the environment is affecting their water supplies.

## CONCLUSION

Projections by the IPCC forecast that the water situation will worsen over the next thirty to fifty years, due to both population growth and climate change. Indicators and warnings to observe are the "water stress" points in each country. How far below the minimum 1000 mcm per person is each country, based on their population size and water tables? As water tables decrease and populations grow, what is the economic status of each country, and its ability to provide food for its own people. Observers should also pay attention to both efforts at cooperation and the possibility of conflict between countries over water resources. Analysts concerned about U.S. National Security should

[494] Rhett A. Butler, "Deforestation in the Amazon," Mongabay.com, entry posted 2008, http://www.mongabay.com/brazil.html, (accessed June 5, 2009)

also pay attention to the possibility that decreased agriculture productivity and the resultant social unrest could lead to an increase in instability and terrorism.

The underlying question of this examination is what can and should the United States and Europe do to help the affected countries and their populations about their water problems, before the situation becomes critical? The United States and Europe depend on the Middle East/North Africa region for energy, and Latin America for both energy and food, so the stability of these regions is in their shared interest. Speeches by leaders have emphasized improving the situation in these regions; the foundation of such efforts has to focus on current and future food and water needs that are essential for each region's stability. The U.S. and Europe need to assist the United Nations in reaching its water goal, which is to reduce by 50% the number of people without sanitation and safe drinking water.[495] This can be done by providing education and expertise, so developing nations can better manage their water resources. The objective for the countries of these regions should be to achieve water security. Water security is defined as ensuring that every person has access to enough water at an affordable price, in order to lead a healthy life, while maintaining an environment that provides sustainable water use now and in the future.[496]

The United States and Europe need to work with both the political and religious leaders of these regions, to achieve a balance between the demands of growing populations and limited water resources. This work will require bringing together countries that share water resources, reviewing data on the falling water tables, and

[495] The United Nations, "Water for People, Water for Life," World Water Development Report, 2003, 6-7

[496] Sawvel, *Water Resource Management,* 35

projecting the impacts of climate change and effects of growing populations. Emphasis needs to be placed on when the demands of the population will exceed the supply, and how cooperative measures can reduce the pending water crisis and the impacts of climate change.

The United States and Europe need to ensure that the developing world understands that an increased demand for water that exceeds supply, will drive up the economic costs. The United States and Europe also need to take on this responsibility as diminishing water resources will affect the both their economic and food security. They also bear a responsibility for the climate changes that are occurring in the developing world. Every nation needs to understand that their actions with regard to water have an affect on other nations, the region, and ultimately the world. How Peru's water resources are being affected by climate change will affect the amount of food it exports. Its inequitable distribution of water between the rich and poor will only exacerbate the problem and increase tensions, if Peru is forced to divert more water to agriculture.

Managing water resources comes with various challenges, and actions taken today affect future generations. These challenges include balancing internal competing demands for water, such as the environmental concerns vs the industrial desires, the challenge of providing clean water at an affordable cost to the population, and lastly the challenge of managing a shared water resource with multiple countries. The United States and Europe need to ensure each nation has a plan that correlates with its neighboring countries' plans for solving the water challenges it faces. Based on the issues in the region, the solutions will not always be the same. Funding must be set aside to address the issues of sanitation and safe drinking water, specifically reducing water

borne diseases, building water and sewage treatment plants, and cleaning up water resources. Funding must also be spent educating developing countries on proper irrigation practices, and learning how to better manage their water resources.

Researchers note that the water issues will lead to food issues as "40 percent of the world grain harvest is produced on irrigated land, therefore, a water shortage will become a food shortage."[497] One recommendation is for the United Nations to enact regulations concerning which food products can be grown in certain parts of the world, based on the amount of water that crops require. Developing countries have to understand that in the globalized world, with growing populations and changing climates, a nation can seldom be self-sufficient in food production. Since water and food issues are global issues, then countries need to work together by sharing knowledge and expertise, to find global solutions.

The United Nations World Water Report states that: "Recent estimates suggest that climate change will account for about 20 percent of the increase in global water scarcity."[498] The report shows anywhere between 2-7 billion people facing severe water scarcity. Due to increased suffering, populations may migrate. With the possibility of increased suffering, migration, and resentment leading to instability, the United States needs to work with the international community to find solutions before these events occur. The cost of being proactive in dealing with the pending water crisis will be far

[497] Web of Creation: Ecology Resources: Transforming Faith and Society, "Problem: Fresh Water and Oceans in Danger," http://www.webofcreation.org/Earth%20Problems/water.htm, (accessed May 31, 2009)

[498] The United Nations, "Water for People, Water for Life," World Water Development Report, 2003, 10

less expensive, than sending humanitarian aid or combat troops to stabilize countries that can no longer support their citizens.

This thesis has shown the status of the water resources in selected countries in three regions of the world, the potential impacts of climate change in these regions, and the potential for both conflict and cooperation. The main concerns for the United States are that a decrease in water availability in these regions will affect food production, which will affect both global economic security and hunger; that decreased water availability can lead to poverty and instability which can become a breeding ground for conflict and terrorism; and that all of these can lead to migrations which will affect regional stability. The United States needs to take a more proactive role in helping to solve these global water issues, to prevent the implications for U.S. National Security and help provide solutions that will benefit everyone. The way forward will require hard decisions, but the consequences of not making these decisions far outweigh the costs.

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