AROUND THE RIVER BEND:

GLOBAL CLIMATE CHANGE, WATER SECURITY, AND THE IMPLICATIONS FOR CANADA

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Authors:

Rachael Andrew
Blake Barkley
Raj Bhinder
Steven Chadwick
Patrick Chapman
Bartek Drobniak
Kimo George
Kaleigh Heard
Andrew Hrivnak
Emily Jones
Alexander Kuhn
Joshua Lerner
Elizabeth Maze
Brett MacFarlane
David Olejnik
Chris Robinson
Vindya Seneviratne
Melinda Stevenson
Laura Sullivan
Jessica Thrower
Rachel Thompson
Richard Vitari
Selina Wamsley
Luke Wilson
Jocelyn Wolfe

Under the supervision of:

Prof. Tom Deligiannis
Department of Political Science
University of Western Ontario

EXECUTIVE SUMMARY

This report explores the issue of climate change and water security in a wide variety of regions around the globe. The key issues to be addressed in each section are summarized as follows:

(a) *NORTH AMERICA.*

The effects of climate change are expected to have diverse yet interconnected impacts on water security in North America. Due to the regions expansive landscape and its abundant supply of freshwater resources, the impacts of water security will not be uniform across the continent. In Canada, gradual warming is set to decrease snow and ice coverage in the Arctic and Central regions, while the Southern areas are expected to experience water availability challenges due to decreases in precipitation. Similarly, the impacts on water security in the United States are expected to be even more severe in Southern areas as changes in precipitation patterns will lead to more intense and frequent droughts. In Mexico, warmer air temperatures will likely result in intense tropical storms in coastal regions and decreases in precipitation in Northern Mexico. In analyzing the broad nature of water security challenges in North America, this analysis will focus explicitly on how sectors, agreements and trade relations will be impacted as a result of climate change with a specific focus on water treaties, water trade, agriculture, energy and migration.

(b) *LATIN AMERICA.*

The effects of unabated climate change are expected to have profound and far-reaching consequences on water security in Latin America. While Latin America has a comparatively strong adaptive capacity, weak regional and state-level water governance has and will continue to exacerbate issues of water quality, accessibility, sanitation, and regional conflict, as well as highly water intensive industries such as agricultural and energy production. Regional impacts resulting from water insecurity will extend beyond Latin America; Canada may face challenges of increased migration due to regional water insecurity. The section on Latin American will also explore additional effects regional water insecurity may have on Canada and examine foreign policy option that could address some of these challenges.

(c) *MIDDLE EAST.*

The Middle East section of the report will cover issues of water security from a geographic and thematic standpoint. The focus rests on the three main river basins in the region, the Nile, the Jordan, and the Euphrates-Tigris. The discussion will focus on security matters specific to these areas and will provide an overview of potential issues caused by the implementation of domestic adaptation techniques. It concludes with an outline of implications for Canadian foreign policy based on water insecurity caused by climate change in the region.

(d) *ASIA*.

The section on Asia will focus on the effects that climate change will have on water availability in the Tibetan plateau region and the states directly affected by glacial melt within this region. Specific focus will be paid to China, the Mekong River Basin, Pakistan, and the Ganges-Brahmaputra-Meghna River Basin. It will also explore the compensation strategies used in these regions when faced with water insecurity. The implications of these strategies on inter-state relations as well as domestic populations will be analyzed.

(e) *AFRICA.*

Already faced with severe droughts, desertification, and famine, it is clear that Africa will face the negative impacts of climate change and water insecurity more than any other region. Many areas likely to suffer have primarily agricultural economies, poor governance and weak state capacity. These states also face issues of massive population growth and significant migration. The Sahel, Horn of Africa, and Southern Africa are likely to face increased drought and desertification and a decrease in precipitation. As such, the section on Africa will focus on how climate change will impact three main areas of concern: agricultural security, health security, and water governance. After examining the implications of water and human insecurity in Africa, the section will explore some potential policy options for Canadian action in Africa.

"We never know the worth of water till the well is dry."

- **Thomas Fuller**

TABLE OF CONTENTS

Introduction

The fundamental cause of global climate change has been attributed to rising levels of anthropogenic greenhouse gas emissions and aerosols resulting from human energy production, transportation, forestry, agriculture and industry. Climate change is expected to have extensive and far-reaching consequences on both the physical environment and on human well-being. In particular, climate change is expected to impact the accessibility and quality of freshwater resources, which will further affect the environment, the availability of food and energy, national economies, and population health. Due to the major impacts that water quality and quantity have on human survival, national prosperity, and international stability, water security is an increasing concern for governments around the world. It is an issue that requires an international response.

Throughout the 1965-2005 period, the IPCC 2007 AR4 assessment accounted for a linear warming trend of 0.13°C per decade.[1] While this assessment outlines a global average, different regions of the world have observed variable physical impacts based on geographic location. In addition to the physical impacts of climate change, there is expected to be numerous secondary impacts on populations around the world. One critical concern is that it is expected that many communities will experience a scarcity of freshwater resources. As it stands, CO_2 emissions are currently being released at an annual rate of 35,000 million metric tons per year and are expected to increase to 41,000 by 2020.[2] Current CO_2 emissions are expected to be the most concentrated than any other time in the last 15 million years. Finally, it is believed that the global mean temperature has reached 0.8°C above preindustrial levels.[3] There is more than enough sufficient evidence to demonstrate that climate change is a real problem, and that it will have profound effects on the most basic human necessities.

Although issues of water security resulting from climate change are expected to have greater impacts abroad, Canada's endowment of this finite resource will pose several new challenges to the country and its role in the international community. First, Canada may be required to provide additional humanitarian assistance to water scarce regions. While Canada currently promotes human security abroad, action and assistance may be demanded from countries where Canada has not acted

[1] IPCC, 2007: *Climate Change 2007 Synthesis Report: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)] (Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA), 30-32.
[2] A Report for the World Bank by the Potsdam Institute for Climate Impact Research and Climate Analytics, *Turn Down the Heat: Why a 4C Warmer World Must be Avoided* (Washington, D.C: International Bank of Reconstruction and Development, 2012), xiii-xv.
[3] Ibid, xiv.

historically or does not have an evident direct interest. A second major issue for Canadians will be the impacts that water scarcity, both at home and abroad, will have on the national economy. The globalization and the internationalization of the Canadian economy have created a system of dependence based on trade and commerce. In order to grow and prosper, the Canadian economy requires a certain level of international stability and confidence. If water scarcity undermines national or regional economies, Canadian businesses will also be negatively impacted. As both of these issues illustrate, the impacts that climate change will have on global water supplies will affect Canadian resources, foreign policy, and economic prosperity. Thus, it is necessary for current policymakers to know where future risks lie so that Canada can act presently to prevent serious global water insecurity before it threatens future Canadian interests.

In addressing the complexity of the water security issue, this study seeks to examine water security in the context of climate change from both a Canadian and global perspective. The objective is to provide Canadian policy makers with the most recent and comprehensive assessment of the challenges that the global community will face in gaining access to freshwater resources as temperatures continue to rise. We adopt a normative approach and takes the position that countries should have access to sufficient water resources in order to support their populations, and that water quality levels must be safe for consumption. The report aims to guide the decisions of policymakers when deliberating future national and foreign policy strategies. The study will focus on regions that Canada already has vested interest in, and other potentially vulnerable areas where the impacts of climate change on water security are expected to be serious enough that Canada should be prepared to act. We seek to provide a realistic assessment of the potential for water scarcity, in light of the global consequences of climate change, for the purpose of protecting and maintaining Canadian interests at home and abroad. In order to accomplish this task, the study has been divided regionally based on continental concerns. The continental regions that have been selected for examination are: North America, Africa, Middle East, Latin America and Asia. Although the analysis below does not address all regions or countries in the world, many of the global themes and wider issues related to water security will be illustrated in our analysis. In many cases, these illustrations are representative of wider risks facing other regions or countries not discussed in the report.

In choosing which regions to focus on, we use three main considerations. First, it was necessary to include countries that Canada currently has a close relationship with and which reflect long-standing Canadian interests. Second, the authors decided to focus on regions where water resources will be most severely impacted by climate change. Finally, the authors decided to focus on regions that do not have the institutional capacity to deal with water insecurity, and, as a result, may threaten regional stability or the stability of the international system in the future. In this regard, an analysis of North America was considered necessary because of the strong

diplomatic and regional trading interests that Canada has with the United States and Mexico. Water insecurity anywhere in North America will have real and direct effects on Canada and will likely require a strong Canadian response. Although Western and Eastern Europe also have close ties with Canada, the report recognized that these regions have the institutional and adaptive capacities to deal with threats posed to their water resources. The physical separation between these regions and Canada means that the Canadian government will likely need to play a very small role if any. By focusing instead on Africa, the Middle East, Latin America and Asia, this paper will examine the impacts that water security will have on the individual, the state, and the international community, and the implications of these impacts for Canada.

In order to provide a thorough and in-depth analysis of the challenges that climate change poses to each region's water resources, this study was created using regionally specific working groups. This method has resulted in a multitude of diverse approaches to examining this issue. Some regions decided to take a state based approach, while others confined their analysis to specific water basins. The different approaches taken by each working group ensures that different regions were analyzed in a framework suited to their specific national concerns. Although the approaches are not uniform, the cumulative analysis below will hopefully yield the greatest results for Canadian policy makers in the future.

In guiding the future decisions of Canadian policy makers, this study bases its recommendations on the most recent and up to date scientific analysis. The scientific forecast portion of this report will be the foundation for examining how climate change and its associated temperature increase will impact water resources. The following section will provide temperature projections for individual regions, as well as a forecast of the global average temperature increase.

Defining *Water Security*

WATER SECURITY is a multidimensional concept, encompassing water resource quality and quantity, and the effects that these factors have on the environment, the availability of food and energy, the economy, and population health. A lack of water security can undermine the security of the individual, the community, and the state, which in turn, can create instability in the international system. Given the importance that water security has on all levels of society, this paper takes the approach that *there should be a human right to water.*

Both the quality and quantity of water resources are implicit in determining whether or not a country is 'water secure.' In relation to the safe quantity of water resources, security does not refer to absolute supply of water, but instead refers to the supply of water relative to the demand.[4] By contrast, water quality refers to the chemical, physical, and biological characteristics in describing and evaluating the quality of water with respect to a specific use, such as aquatic habitat, drinking water, or irrigation.[5] The connection between water quality and quantity is extremely important for the overall health of the environment and the sustainability of human life because it influences the availability of food and energy, impacts the economy, and is essential to population health.

By 2050, the global population is projected to increase to approximately 9 billion people[6] and water supply is expected to decrease as a result of climate change. This means that many states will experience water security issues because there will be a greater demand to use water for agricultural, industrial, energy, and household purposes, despite reduced supply. One way in which the issue of reduced supply will appear is in the climate-water-food nexus. Climate change is expected to increase the severity and frequency of droughts, which will decrease the amount of water available for food production. Areas that are prone to droughts may subsequently face periods of food scarcity if there is not enough water to produce the amount of food that the population demands. The production and availability of energy will also be challenged as a result of water shortages. Energy production requires water for the extraction, processing, and transportation of primary energy fuels, and is also critical to the generation of most forms of electricity. Moreover, energy is a key component in the extraction, purification and transportation of water. Although there

[4] "FAO/Netherlands Conference: Glossary." FAO: Food and Agriculture Organization of the United Nations, for a world without hunger. http://www.fao.org/ag/wfe2005/glossary_en.htm
[5] Ibid.
[6] United Nations, Department of Economic and Social Affairs, *World Population Prospects: The 2010 Revision, Economic and Social Affairs*, (New York: The United Nations, 2011), 1.

will be increased demands for energy in order to facilitate human and industrial activity, water shortages may limit its production. The relationship that water quantity has to the production of food and energy means that consistent water insecurity will undermine the stability of national economies and human life in these regions. It is therefore of great national importance that states take measures to deal with incidences or periods of water shortages in order to mitigate negative effects.

In addition to having an adequate supply of water, a state must ensure that its water meets minimum safety standards. Although these standards have largely been determined by domestic policy, in 1993, the World Health Organization (WHO) advocated creating international standards to ensure "the safety of drinking water supplies through the elimination, or reduction to a minimum concentration, of constituents of water that are known to be hazardous to health."[7] This is due to the fact that water related illnesses and diseases have created a health crisis in certain regions of the world. The United Nations has reported that dirty water and poor sanitation are a major cause of preventable illness, resulting in 1.4 million child deaths per year, and accounting for almost a quarter of global child mortality. Moreover, the WHO argues that water borne diseases are responsible for approximately 2.2 million diarrheal deaths per year alone, while the Johannesburg Summit in 2002 estimated a total morbidity of 5 million/year due to consumption and use of unsafe water.[8] Increased frequency and severity of flooding related to changes in seasonal runoff, and changes in precipitation patterns as a result of climate change are important factors of water quality. Consequently, regions that are expected to experience increased flooding may also expect the health implications that accompany this physical consequence of climate change.

The absence of sufficient and adequate water resources poses immense difficulties for the individual, the community, and the state. If individuals do not have access to the basic necessities of life such as food and water, or do not feel as though they can achieve a reasonable standard of living, they may be forced to migrate either within their own country or across state borders.[9] If large numbers of people migrate, this will further strain the water resources of the destination area, which could lead to instability in the region.[10] In addition, there is also a fear that terrorist groups will attack water systems through the contamination of water or through the destruction of purification and supply infrastructure because of its importance to the smooth functioning of society.[11] Both migration and water terrorism in this sense have the potential to increase the chances of societal

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[7] International Union for the Conservation of Water. "Content of a Right to Water". http://data.iucn.org/dbtw-wpd/html/EPLP-051-water-human-right/IV.%20Content%20of%20a%20right%20to%20water.html

[8] Gleick, Peter H. "Dirty Water: Estimated Deaths from Water-Related Diseases 2000-2020. Pacific Institute Research Report. August, 2002.

[9] Norwegian Refugee Council. *Future floods of refugees: a comment on climate change, conflict and forced migration*, (Oslo, Norway: Norwegian Refugee Council, 2008), 21.

[10] Ibid, 21.

[11] Peter H. Gleick, "Water and Terrorism," *Water Policy*, 8 (2006): 481-503, 481.

disruptions, disarray, and the overreaction of governments and the public, possibly contributing to intrastate and interstate conflict.[12] Although historically conflict over water has not been common, individual and national security could be seriously threatened from water insecurity.

Due to the potential disastrous impacts that water insecurity can have on the individual, the state, and the international level, this report asserts that the right to water should be universal, and that it is each state's responsibility to ensure that their citizens have access to this right. At the individual level, water security entails three core freedoms: "freedom from want, freedom from fear and freedom to live in human dignity."[13] These freedoms necessitate that every person has access to sufficient and affordable safe water so that they may lead a healthy and productive life, while simultaneously securing the protection and continued maintenance of the environment. The international community has already started to recognize water as a human right in the creation of the Millennium Development Goal project.[14] Here, the international community stated that it wanted to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.[15] Despite this recognition by the international community, the method of guaranteeing water rights is currently haphazard and there is no unified policy on how to ensure water security internationally. Moreover, individuals, communities, states, corporations, non-governmental organizations, and intergovernmental organizations have all approached the issue of water security in different, and sometimes diametrically opposing ways. Thus, the international community should focus on broad principles that will help guarantee the universal right to water but allow states to address specific water security problems in the manner which they see fit.

In light of the growing importance of global water security, many states have enacted systems of water governance in an attempt to mitigate the impacts that climate change will have on water quantity and quality. Water governance can occur multilaterally or bilaterally, through international treaties and agreements, or unilaterally, through policies adopted by a nation state. Water governance identifies the various interests and objectives of a society and creates administrative, political, social, and economic systems that can regulate water resources in order to achieve these goals.[16] Typically, water governance programs have focused on conservation efforts that preserve, maintain, restore, and enhance the water resources that a

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[12] Ibid, 481
[13] Patricia Wouters, "Water Security: What Role for International Law?" ed. Felix Dodde, *Human and Environmental Security an Agenda for Change* (London: GBR Earthscan Publications, 2005): 169.
[14] "Human right to water and sanitation, International Decade for Action 'Water for Life' 2005-2015." United Nations. http://www.un.org/waterforlifedecade/human_right_to_water.shtml
[15] Ibid.
[16] Peter Rogers, and Alan W. Hall, *Effective Water Governance* (Sweden: Elanders Novum, 2003), 16.

country has in order to ensure long-term benefits to current and future generations.[17] This can be done through increasing the efficiency of water use, production, and distribution, and may involve altering current water practices to ones that are less depleting or wasteful. When water governance systems are created between two or more states, there has also been a focus on the control of water resources to ensure that upper riparian states are not restraining or contaminating water that flows downstream and into neighboring countries. To ensure that various management and cooperation agreements are being implemented, states or other international organizations may monitor water quality and quantity. If specific parameters are not being met, activities and budgets may be adjusted in order to obtain the previous objectives or to introduce improved objectives.[18] Failure to comply or meet the statutory requirements may also be subject to legal action, thereby ensuring that key actors are held accountable. As water becomes less secure as a result of climate change, water governance will play a vital role in ensuring national, regional, and international stability because it fosters cooperation and coordination of actions among state actors.

[17] "European Environment Agency: Glossary 'Conservation'." European Environment Agency. http://glossary.eea.europa.eu/EEAGlossary/C/conservation

[18] " Status and Monitoring Overview." European Environment Agency. http://www.eea.europa.eu/themes/water/status-and-monitoring

Forecasting Future Climate Change

In guiding the future of the Canadian Federal Government's climate change policy on water security, this paper seeks to evaluate the most recent scientific evidence. The purpose of forecasting a global average temperature is to help better understand the changing physical factors that could face the international community between the 2020-2050 period. After assessing the most recent and comprehensive scientific evidence, this report concludes that limiting the global average temperature increase to 2C is highly improbable. In analyzing the impacts of climate change on water resources from both a Canadian and global perspective, this report forecasts that a 2.5-3.0C increase in the average global temperature is a more realistic target.

Under the auspice of the United Nations, the international community has collectively agreed to limit the global average temperature increase to 2C above preindustrial levels. Pursuant of the recommendations outlined by the IPCC, the most recent targets set at the 2009 Copenhagen (COP-15) meeting continued to enforce mitigation efforts aimed at this target. Under the Copenhagen Accord, several developed states, including Canada, agreed to voluntarily reduce emissions in order to achieve this target; Canada's targets are set at 17 percent reduction based on 2005 levels.

If the Canadian government's response to climate change is to be informed by science, the likelihood of humanity limiting global warming to 2C above pre-industrial levels can no longer be considered a plausible target.[19] A recent re-evaluation of the latest scientific data suggests a high probability of exceeding a 2C global temperature increase by 2050. Huntingford et al conclude that humanity has a 50% chance of exceeding a 2 degree increase if emissions reductions are around 3% per year, with emissions peaking in 2014.[20] Achieving a higher certainty of keeping temperatures at 2 degrees or a later peak emissions year would require higher yearly percentage increases. [21] Unfortunately, recent trends in global emissions over the last 20 years have not reduced or even stabilized emissions; they have increased. As of 2011, global CO_2 emissions have risen to an all-time high level of 34 billion tonnes, while emissions of all greenhouse gases have risen to about 50 $GtCO_{2eq}$ in 2010.[22] Rogelj et al recognize that a 50% chance of constraining warming to 2C requires

[19] New et al, "Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications," *Royal Society Publishing* (2011) 269: 3, 8-10.
[20] Huntingford et al., "The Link between a Global 2C warming threshold and emissions in year 2020, 2050 and beyond," *IOP Publishing: Environmental Research Letters* (7): 2012, 5.
[21] Ibid.
[22] PBL Netherlands Environmental Assessment Agency, *Trends in Global Co2 Emissions: 2012 Report,* European Commission Joint Research Center (2012), 17. UNEP, *The Emissions Gap Report 2012* (Nairobi: United Nations Environment Programme (UNEP), 2012), 1. Since other gases like methane also warm the planet like CO_2, scientists have created a composite measure of global warming forcing, measured in gigatones of carbon dioxide equivalents - $GtCO_{2eq}$.

developed countries to cut emissions by upwards of 80% below 1990 levels by 2050.[23] Recent trends, however, indicate that while the share of global emissions has changed, no cumulative reductions have been made. In 1990, the developed world accounted for 68% of Co2 emissions, versus 19% for developing countries. As of 2011, the shares of developing countries have increased to 55%, while the developed world has decreased to 41%.[24] In addition, a recent re-evaluation of the IPCC AR4 assessment has been revised to account for the 2C target no longer representing a threshold between acceptable and 'dangerous' climate change, but between 'dangerous' and 'extremely dangerous' climate change.[25]

In terms of mitigation, there continues to be an absence of any meaningful global action to reduce emissions or set binding targets. Despite the recent targets established in Copenhagen, den Elzen et al have concluded that an emissions gap exists between the Copenhagen pledges and the 2C climate goal. In order to have a 50% chance of meeting the 2C target by 2050, 2020 emissions would have to range between 42-46 $GtCO_{2eq}$.[26] If all Annex I (developed countries) and the seven largest non-Annex I (developing countries) fully implemented their conditional, *non-binding* pledges, the global emissions level could only be as low as 48.6 $GtCO_{2eq}$ by 2020. Thus, even if the Copenhagen pledges were fully implemented there remains a pivotal gap between the high level of aspirations and the scientific reality of reaching a 2C target.[27] The conclusion that follows from these assessments suggests that there is a small chance of remaining below the 2C target.[28]

For the purpose of our analysis, this report will operate under the basis of two scenarios that each identifies the likelihood of limiting the global average temperature. Both scenarios, which have been labeled as the *lower* and *upper* scenario, will be based on the emissions reduction targets that have been pledged at the 2009 Copenhagen Conference.[29]

(1) **Lower Scenario**: An ambitious, yet achievable scenario based on the optimistic assumption of full compliance with conditional targets by 2020 pursuant to the

[23] Rogel J et al., "Halfway to Copenhagen, no way to 2C," *Nature Reports Climate Change,* accessed March 4th, 2013, http://www.nature.com/climate/2009/0907/pdf/climate.2009.57.pdf
[24] PBL, *Trends in Global co2 Emissions,* 17.
[25] Anderson, Kevin and Alice Bows, "Beyond 'dangerous climate change: emission scenarios for a new world," *Philosophical Transaction of the Royal Society* (2011) 369: 10, 20-21.
[26] Den Elzen et al., "The Emissions gap between the Copenhagen pledges and the 2C Climate goal: Options for closing and risks that could widen the gap," *Global Environmental Change* 21(2), (2011), 739.
[27] UNEP, *The Emissions Gap Report 2012*, 1.
[28] Guivarch, Celine and Stephane Hallegatte, "2C or not 2C?" *Global Environmental Change 23* (2013), 179-180.
[29] In establishing each of these scenarios, this report took two approaches. Firstly, the scientific basis of the report is based on a culmination of the most recent and up-to-date scientific climate research. This report utilized scenarios that have been established by the most authoritative sources, such as the IPCC, IEA, and the European Joint Commission in order to provide the most realistic assessment of future global climate projections. In addition, it examined the most recent academic scholarship on this subject in order to gain a complete understanding based on expertise in the field. Secondly, this report adopted the targets established at the 2009 Copenhagen Conference as they are the most recent state based pledges made at the international level. This provides us with a foundation for analysing the potential for states to either fully, partially, or completely abandon working towards the emissions reductions that they have agreed upon. It should be noted, however, that in exploring scenarios it is highly unlikely that the future will follow a precise path. The purpose of this section, therefore, is to explore a range of scenarios that attempt to demonstrate the potential for different global average temperature paths based on the availability of the most recent scholarly information. The scenarios outlined in this section are not intended to be a forecast, but instead a realistic model of how the global climate may evolve under certain political conditions. Such projections are sensitive to technological advancements, economic growth (both globally and at a state level), energy supply and demand, energy prices, geopolitical events, and government policy. In the short and medium term, there is greater potential to predict realistic global energy trends. In the long term, however, there exists much greater uncertainty. It is therefore important to note that the projections made in this section are based on targets set at the recent Copenhagen Accord; however, they are also subject to various future contingencies.

Copenhagen Accord. This scenario recognizes that the facilitation of such targets will be accompanied by a high level of technical, social and political innovation in order to reach established goals. This scenario expects an average global temperature increase of 2.5C-3C based on Global Total Emissions of 46.7% by 2050.[30]

(2) **Upper Scenario**: Based on the lack of progress that has historically taken place in emission reduction targets, this scenario recognizes a continued disregard for decreasing global greenhouse gas emissions (GHG). It assumes that states will fail to comply with reaching their established conditional targets by 2020, pursuant of the Copenhagen Accord. This high-baseline scenario adopts the Business-As-Usual (BAU) approach, which accounts for the continued growth of GHG emissions in the atmosphere. This reflects the continuation of current energy-subsidy policies, which implies high energy consumption and consequently high GHG emissions.[31] This scenario expects an average global temperature increase of 4C-5C based on Global Total Emissions of 60.6 $GtCO_{2eq}$ by 2050.[32]

Looking at regional projections, previous studies have thoroughly concluded that the annual mean air temperature in North America will likely rise in the coming decades. Geographically, Alaska and North-Western Canada have shown the most significant warming, followed by the continental interior and southeastern US.[33] In coming decades, it is likely that that the majority of the United States will see a rise of a 2-3.5°C that coincides with the predictions set out in the low scenario.[34] Additionally, using two regional climate models developed for the North American Regional Climate Change Assessment Program, researchers projected that the Hudson Bay region would experience the largest temperature swings with a high end assessment in temperature rise of approximately 6°C. In the Midwest and Great Lakes region the statistical analysis determined an average temperature increase of 2.8°C.[35]

Moving south, Latin America will also see drastic changes to their climate and environment should global warming continue at its current pace. Using projections based on the IPCC AR4, many studies have established (specifically 19 of 21 general circulation models) that there will be a general decrease of precipitation within the region. Moreover, based on a 2006 index which measured projected changes in the mean and variance of precipitation and temperature, Karmalkar et al. (2011) determined that Latin America would be a 'climate change hot-spot' with larger changes than any other region within the tropics.[36] Using a general circulation model

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[30] Huntingford et al., "The Link between a Global 2C Warming," 5-6.
[31] IPCC, *Working Group III: 7.3.2.3 Baseline Scenario Concepts*, accessed March 3rd. http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=286
[32] Huntingtford et al., "The Link between a Global 2C Warming," 5-6. UNEP's recent survey of the literature projects total emissions of about 85 $GtCO_{2eq}$ by 2050. See UNEP, *The Emissions Gap Report 2012*, 23.
[33] Chen, Rachel J.C. "Effects of Climate Change in North America: An Overview." *Journal of Sustainable Development* 4.3 (2011): 33
[34] National Climate Assessment and Development Advisory Committee Draft Report (2013): 35. http://ncadac.globalchange.gov/download/NCAJan11-2013-publicreviewdraft-chap2-climate.pdf
[35] Gorder, Pam Frost. "Statistical Analysis Projects Future Temperatures in North America."*ScienceDaily*. 15 May 2012. Web.
[36] Hidalgo, Hugo G., and Eric J. Alfaro. "Some Physical and Socio-economic Aspects of Climate Change in Central America." *Progress in Physical Geography* 36.3 (2012): 381.

which simulates global climate numerically and displays historical and future projections of climate findings, it can be determined that Latin America will likely stay within the target range outlined by the low scenario. Both Hugo G. Hidalgo and Eric J. Alafaro project that a rising of 1°C is expected to be seen across most Latin American states by the mid-century mark, and a rise of more than 2°C is projected to be seen by the end of the century.[37]

In all likelihood, Africa will experience the most extreme fluctuations in its environment (i.e. increased dry spells, flooding, and temperatures) from global warming due to its high vulnerability to climate variability and low adaptive capacity. While post-IPCC AR4 research on changes in climate extremes has been limited, as most reports have focused on the end of the twenty-first century projections, there have been several notable studies on Africa's future climate. By analyzing projections based on regional models, Sylla et al. (2010) predicted an increased likelihood of dry spells over the western Sahel and West Africa regions. Also worth noting is a study conducted by Paeth et al. (2009) which projected significantly longer dry spells over tropical and sub-Saharan Africa.[38]

The Middle East and the Eastern Mediterranean are expected to be greatly affected by climate change, with increases in the frequency and intensity of droughts and hot weather conditions. Since extreme climate conditions are already common within the region, the impacts of global warming could potentially be disproportional. For example, the results of the PRECIS (Providing Regional Climates for Impact Studies) regional climate model index show that regional warming will gradually increase in the near-future (2010-2039) by 1-3°C which would align with the optimistic targets that have been set forth by the low scenario.[39] As a result, further projections indicate that the intensity of precipitation within the region will likely decrease as the number of dry days, already exceptionally high in the Middle East, will see little change. Should this projection hold true, the lack of precipitation will severely impact the region's major river systems and could negatively affect both downstream water resources and food production.[40]

Lastly, in South Asia there has been an increasing intensity and frequency of droughts in the region, with a linear decrease of 7.5% in rainfall from 1900-2005.[41] Using a 'pattern scaling' method, which calculates the rate at which local average seasonal temperature or rainfall changes, with increases in average global temperature over multiple decades, general estimates predict that the region will experience a 0.8°C rise by 2030 assuming states begin to enact stronger environmental policies. Should the high scenario persist with little government action, South Asia could see a 6°C rise in temperature by 2070.[42] Looking ahead,

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[37] Ibid, 386.
[38] Vizy, Edward K., and Kerry H. Cook. "Mid-Twenty-First-Century Changes in Extreme Events over Northern." *Journal of Climate* 25 (2012): 5749.

[39] Lelieveld, J., P. Hadjinicolaou, E. Kostopoulou et al. "Climate Change and Impacts in the Eastern Mediterranean and the Middle East." *Climatic Change* 114 (2012): 678.
[40] Ibid, 668.
[41] Sivakumar, Mannava V.K., and Robert Stefanski. *Climate Change and Food Security in South Asia.* Springer, (2011): p 18
[42] Preston, J., Benjamin, Ramasamy Suppiah, et al. "Climate Change in the Asia/Pacific Region." *CSIRO Marine and Atmospheric Research* (2006): 21.

South Asia will also face numerous challenges which will threaten its people's livelihoods and surrounding environment. For example, annual river runoff and water availability will likely decrease by 10-30% over various regions at mid-latitudes. In addition, accelerated glacier run-off in the Himalayan –Hindu Kush mountain range could ultimately threaten the capacity of numerous flowing rivers.[43]

Examining Canada separate from North America forecasts indicate that its temperature increase due to climate change will be particularly high over the next 40 years because of warming in the Arctic region. In both the lower and upper scenario, Canada should expect to see large temperature increases in the north, while southern Canada will have lower temperature increases. Historically, Canada has already seen temperature increases. The most recent Climate Trends and Variations Bulletin based on the national average temperature for the winter of 2011/2012 shows that the temperature was 3.6°C above normal (1961-1990 average), which makes it the third warmest winter on record since 1948.[44][45]

The following projections come from the University of Waterloo Climate Change Adaptation report to project likely temperatures across Canada in 2020 and 2050 based on climate trends since the 1970s using a BAU scenario.[46] This model follows under the upper scenario. The projections reveal that temperatures will increase throughout the country, but there are two important regional variations between the Arctic region and the rest of the country. The Arctic will see a warming of 2-4 C by 2020 and 4.5-8 C by 2050 (See below for specific projected temperature nationally: 2020 and 2050 winter).[47] In contrast, the rest of the country will see an increase in warming of 0.5 to 2 C by 2020 and a 2 to 4 C increase by 2050.[48] These projections are under the upper scenario, and would be most felt during the winter. This will have the greatest effect on the agricultural industry. Most of Canada's agricultural sector will have longer seasons with less frost. This could potentially increase crop yield.[49] The most significant concern is positive feedback, where local climate warming further intensifies the already changing climate, the most obvious

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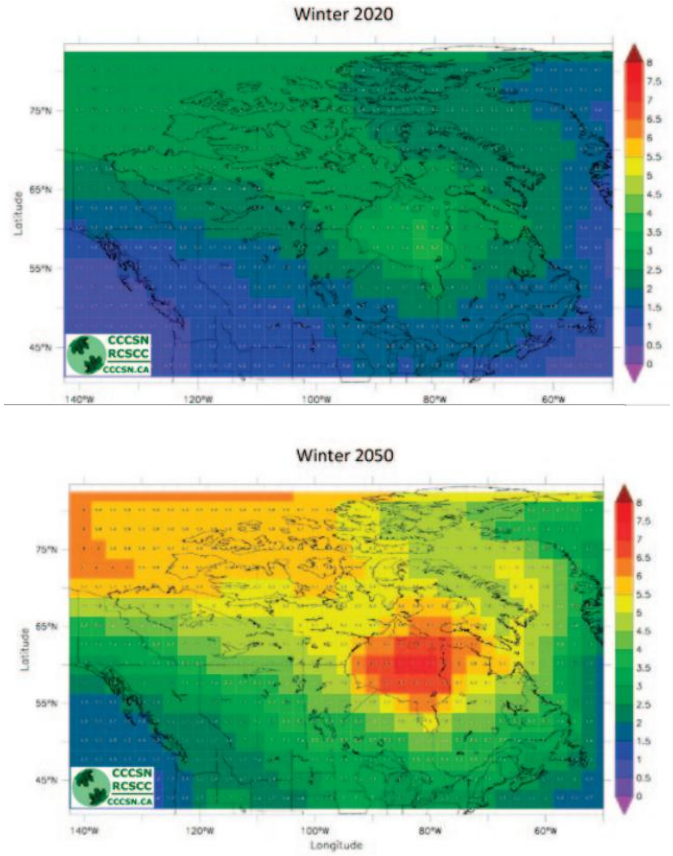
[43] Sivakumar, 23.
[44] Environment Canada . Climate Change. *Climate Trends and Variations Bulletin - Winter 2010/2011*. Canada http://www.ec.gc.ca/adsccmda/default.asp?lang=en&n=8C03D32A-1 (accessed March 7, 2013).
[45] The following historical temperature variations come from Environment Canada. Out of the eleven climate regions, nine experienced their ten warmest winters in 2011 to 2012. They were: the Prairies at 6.3°C above normal; northwestern forest at 6.0°C above normal; Great Lakes/St. Lawrence at 4.0°C above normal; Mackenzie District at 5.5°C above normal; northeastern forest at 3.0°C above normal; North B.C. Mountains/Yukon at 4.7°C above normal; South B.C. Mountains at 2.7°C above normal; the Arctic Tundra at 2.5°C above normal; and lastly Atlantic Canada at 2.3°C above normal. The trends shows that all of the eleven climate regions had increased temperatures from the historical average, with the Mackenzie District showing the greatest trend of 4.9°C over the 65 years of records. Atlantic Canada shows a temperature increase of 0.5°C over the same period
[46] The University of Waterloo's report uses the Climate Change Adaptation report uses climate change scenarios which were developed by the Canadian Climate Change Scenarios Network.[46] This network integrated 24 climate models developed by different modeling centers. By combining the models, this report has reduced the chance of specific model based biases. As such, this data is most likely provide the most accurate projection of temperature increase across Canada. The Models combined 24 A1B emission scenarios. There are several scenarios used, such as the A2 scenario which assumes emission will increase, and the B1 scenario which assumes emission levels will decrease.[46] The A1B scenario is a middle of the road projection and assumes emission will increase more than the B1 scenario, but not as much as the A2 Scenario.
[47] Feltmate, Blair, and Jason Thistlethwaite, "Climate Change Adaptation ." Climate Change Adaptation Project. http://adaptnowcanada.ca/files/2012/08/CCAP-FinalReport-June7.pdf (accessed March 7, 2013). xviii
[48] Bruce, J. Climate Change Information for Adaptation: Climate trends and projected values for Canada from 2010 to 2050. Institute for Catastrophic Loss Reduction, Toronto. 2011. 48 http://www.iclr.org/images/Bruce_climate_change_info_march-2011.pdf
[49] Feltmate, Blair, and Jason Thistlethwaite, "Climate Change Adaptation ." Climate Change Adaptation Project. http://adaptnowcanada.ca/files/2012/08/CCAP-FinalReport-June7.pdf (accessed March 7, 2013). 75

example being the release of trapped pockets of greenhouse gas emissions in Arctic permafrost, which could trigger more intense warming.[50]



[50] Ibid,. xxvii

NORTH AMERICA

Climate Change, Water Security, and North America

Climate change is expected to have significant impacts on water security in North America by the year 2050. These projected impacts will require Canada, the US, and Mexico to develop adaptation strategies in order to cope with changes in water availability, water quality, and climate-altered weather patterns. Water treaties, water trade, agriculture, energy, and migration are the five political spheres that will be most affected by the impacts of climate change on water security. Water treaties will become increasingly important as water demands rise, in order to ensure the fair and equitable use of North America's international water basins. The impacts of climate change on water will also have important implications for the North American trade market, since changes in the availability of water will present economic opportunities and economic threats to various regions across the continent. North American agriculture will also be greatly affected by climate change. Changes in weather patterns and water supplies will require agricultural adaptation strategies that will have political, economic, and social consequences. Energy is also highly significant to North American society, not only as a source of fuel for the economy, but as a major productive sector of the economy. In the context of climate change and its impacts on water security, the energy sector is also particularly important as it is a major consumer (and polluter) of water. Finally, migration patterns in North America are expected to be altered by environmental consequences associated with climate change, with the declining availability of clean water being an important cause of migration for many.

As noted above, Canada is expected to experience gradual warming over the next several decades, with the most significant temperature increases occurring in the Arctic and Central regions.[51] On a seasonal basis, warming is expected to be most prominent during the winter months due to decreasing snow and ice cover causing a rise in land temperatures.[52] Changes in precipitation are more difficult to predict. In general, Canada will experience an increase in mean precipitation over the 21st century, with variations across different regions. In most of southern Canada, precipitation increases are expected to be low, especially in the summer and fall.[53] In the south-central Prairies and southwestern British Columbia, annual summer precipitation is expected to decrease.[54] In addition, groundwater supplies will be

[51] CCIAD, *From Impacts to Adaptation: Canada in a Changing Climate 2007*, last updated 2008, accessed March 2013, http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca.earth-sciences/files/pdf/assess/2007/pdf/full-complet_e.pdf, 48.
[52] Ibid.
[53] Ibid, 51.
[54] Ibid.

altered by increases in the rate of evapotranspiration in semi-arid and arid regions.[55] The ratio of rainfall to snow fall is also expected to increase across the country, which could have significant impacts on the transition from winter to spring in many regions.[56] Temperature increases will also contribute to sea-level rise, which could have an impact on flood patterns and water quality in coastal regions. Arctic sea ice will continue to decrease over the next few decades, with summer ice deteriorating at a faster rate than winter ice.[57]

The US is expected to experience climate change impacts similar to Canada's, with regional variability across the country. Annual precipitation is expected to increase in the Midwest and Northeast regions of the US and decrease in most Southern states.[58] Increasing temperature and changing precipitation patterns are projected to lead to more intense and more frequent droughts in the Southwest and Southeast regions of the country, and in Hawaii.[59] Similarly, flooding is expected to become more intense in nearly all regions of the US, with the Midwest and Northeast experiencing the most significant intensifications due to projected increases in rainfall. Rainfall increases will also likely increase the movement of pollutants and sediment during periods of intense runoff. Changes in precipitation patterns are expected to have a significant impact on the functioning of groundwater aquifers, though the specific consequences of these changes are still relatively unclear.[60] Coastal aquifers will be affected by sea-level rise and more frequent and intense storms resulting from higher temperatures.[61]

As a result of increasing temperatures, Mexico is likely to experience changes in seasonal runoff patterns over the next few decades that could lead to more frequent and intense flooding. There is also projected to be less warming over the Pacific than over other portions of the continent, which is expected to decrease precipitation in Northern Mexico.[62] Over the next fifteen years, inter-tropical glaciers in Latin America are likely to disappear entirely.[63] The disappearance of glaciers, paired with sea-level rise and increased drought, will lead to significant losses in Mexico and Latin America's freshwater resources. In addition, warmer air temperature over the Atlantic will likely increase the frequency and intensity of tropical storms in the region, which could have implications with regards to migration.

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[55] IPCC, *Climate Change and Water IV*, last updated June 2008, accessed February 2013, http://www.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf, 103.
[56] IPCC, Climate Change and Water IV, 102.
[57] CCIAD, From Impacts to Adaptation: Canada in a Changing Climate 2007, 51.
[58] NCADAC, National Climate Assessment (Draft Report), last updated January 2013, accessed February 2013, http://ncadac.globalchange.gov/download/NCAJan11-2013-publicreviewdraft-chap3-water.pdf, 107.
[59] Ibid.
[60] Ibid.
[61] Ibid.
[62] IPCC, *Regional Climate Projections 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, accessed March 2013, http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter11.pdf, 895.
[63] Ibid, 896.

(1) TREATIES AND WATER POLICY

North American watersheds, rivers, lakes, and ground aquifers cross the political boundaries of Canada, the United States, and Mexico. On the continent, water resources are unevenly and irregularly distributed. Inequalities in the distribution and use of water have made it necessary for North American governments to enact water treaties in order to ensure regional water security. These treaties will face new challenges in the future due to population growth, economic expansion, and climate change. Climate change will pose threats to existing water treaties because it will alter water quantity, quality, and water systems operations.[64] In order to ensure that freshwater resources are under effective governance, Canadian policymakers must be aware of the current weaknesses of existing trans-boundary agreements because these deficiencies will only become magnified with climate change.

The effects of global warming are already increasing pressure on water supplies in arid regions, such as in the Great Plains and highly populated areas such as in the Great Lakes. In the Great Plains, climate change has decreased water availability in the area as it has reduced precipitation and has increased evaporation.[65] Although these warmer temperatures have also increased water flows by melting glaciers, some glaciers have already receded so much that their river contributions are dwindling.[66] Thus, as a result of climate change, the Great Plains are projected to suffer from more frequent, more severe droughts. Given the number of people living in the Great Plains, the large population of livestock, and the vast areas of cropland, ensuring future water security is a considerable concern.[67]

The effects of climate change in the region may pose a major challenge to water treaties in instances where one state is expected to deliver a minimum amount of water to another state. This will impact both Canada and the United States because under the Souris River Agreement, for example, North Dakota must deliver 20 cubic feet per second to Manitoba from June to October annually, and the province of Saskatchewan must ensure that the Souris River channel at the Sherwood Crossing will not flow less than 4 cubic feet per second.[68] In future, this minimum requirement may present a problem if the flow and availability of water changes as a result of droughts and Canada or the United States cannot deliver the minimum amount. Although the treaty states that this apportioning of water shall be done "as far as practicable," there is no formalized agreement on what will be done in lengthy

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[64] Ramiro Berardo, and Andrea K. Gerlak, "Conflict and Cooperation along International Rivers: Crafting a Model of Institutional Effectiveness," *Global Environmental Politics*, 12, no. 1 (2012): 101.
[65] "Great Plains Impacts & Adaptation, 'Climate Change - US EPA,' US Environmental Protection Agency, http://www.epa.gov/climatechange/impacts-adaptation/greatplains.html
[66] Adele M. Hurley, *Water in North America: Rising Tensions*, (Toronto: Munk Centre for International Studies, 2006), 6.
[67] Ibid, 6.
[68] "Mandate - International Souris River Board," IJC, http://ijc.org/boards/isrb/mandate/

periods of reduced water flow.[69] In order to prevent serious water insecurity and reduce the likelihood of competition and conflict over water resources, it is necessary that existing water treaties be altered so that they can respond to cases of extreme events, such as droughts. In this regard, Cooley et al. recommends that instead of using fixed minimum flow requirements, water treaties allocate water based on a percentage of flow.[70] This would allow Canada and the US to manage periods of normal water flow and times of drought with mutual understanding and agreement.

Climate change will have somewhat different effects on the Great Lakes. While many consider the Great Lakes to be an inexhaustible freshwater source, this is misleading because the waters are not quickly renewed. It is estimated that only one percent of the water in the lakes is renewed each year.[71] This means that only a small proportion of the Great Lakes can be used in a manner that is sustainable. Climate change will further diminish the quantity and quality of the water in the lakes meaning that states will have to alter their current water practices in order to ensure that these water resources remain secure for future generations.

It will be important for Canada and the United States to better develop its agreements with regards to the water quality. This omission proved problematic for US-Mexico relations in the 1950s and 1960s, when the increasing salinity of the Colorado River damaged crop production in Mexico.[72] As climate change is expected to alter water quality, it is important that water agreements include not only strong mechanisms for monitoring and addressing water quality concerns, but also ways to punish actors that jeopardize water sources.

One mechanism in need of reform is the International Joint Commission (IJC). The IJC was created to deal with Canada-U.S. trans-boundary water disputes, but its effectiveness has been called into question.[73] This is due to the fact that referrals from both countries are required in order for the IJC to investigate a case.[74] This became a major issue in 2005 when the state of North Dakota decided to divert Devil's Lake into the Sheyenne River in order to keep the lake from flooding into surrounding lands. This decision faced stiff opposition from both Canadian provincial and federal governments because it introduced foreign pathogens, species, and pollutants into Canadian lakes and threatened Manitoba's fisheries.[75] Canada wanted to refer the case to the IJC because the Commission had a reputation as a fair and impartial judge that made rulings based on scientific fact as opposed to

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[69] Ibid.
[70] Heather Cooley, Juliet Christian-Smith, Peter H. Gleick, Lucy Allen, and Michael J. Cohen, *Understanding and Reducing the Risks of Climate Change for Transboundary Waters*, (Oakland, California: Pacific Institute, 2009), 9.
[71] International Joint Commission. *Protection of the Waters of the Great Lakes: Review of the Recommendations in the February 2000 Report*. Ottawa, ON: International Joint Commission, 2004, 1
[72] Heather Cooley, Juliet Christian-Smith, Peter H. Gleick, Lucy Allen, and Michael J. Cohen, *Understanding and Reducing the Risks of Climate Change for Transboundary Waters*, (Oakland, California: Pacific Institute, 2009), 6-7. It took extensive negotiations and agreements to amend the Colorado River Treaty to ensure that water deliveries to Mexico were subject to salinity thresholds so that this disaster would not occur in the future.
[73] "News Indepth: Devil's Lake." CBC. http://www.cbc.ca/news/background/water/devilslake.html
[74] "About the IJC." International Joint Commission. http://www.ijc.org/en_/About_the_IJC
[75] "Devils Lake." The Council of Canadians. http://www.canadians.org/water/issues/Devils_Lake/index.html

political considerations.[76] Moreover, it was believed that the US would obey any ruling created by the IJC since the body operates via consensus. By the time the IJC issues a ruling, Canada and the US have usually agreed to follow it.[77]

However, the US would not refer the Devils Lake case to the IJC. This shows that domestic political factors impact national responses to water issues. In Kevin Ma's paper "Canada-US Relations and the Devils Lake Dispute," Ma argues that key political changes in the United States from 2001 to 2005 created a political climate that stopped the US from supporting an IJC referral.[78] The events of 9/11 focused America's foreign policy solely on security concerns. By 2004, the United States was dealing with two wars and issues of "climate change, trade liberalization, terrorism, missile defence, [and] border security."[79] During this time, Canada was also trying to deal with the United States on other issues such as "softwood lumber, Alberta beef, [and] the Kyoto Protocol" – all issues remote from Washington's key concern, security.[80] Moreover, the Chretien and Martin governments had poor relations with the Bush administration because of Canada's decision to stay out of Iraq and our position on missile defence.[81] Thus, due to the political climate, getting the American government to agree to an IJC referral was difficult. The impact that domestic political factors in the United States had on the U.S. decision not to support a referral indicates that the ability of IJC to deal with future water disputes could be undermined by political imperatives.

Increasingly prominent issues of climate change-related water quality and quantity suggest the need to amend the requirement for both states to refer cases to the IJC. Allowing referral by either state, rather than both, would likely enhance scientific knowledge concerning the disputed body of water, and produce politically neutral data.[82] This would aid the Canadian and U.S. governments in attaining diplomatic solutions to water problems by helping to define the problem and facilitate a shared understanding of the impacts of potential actions. This could pave the way for developing and implementing adaptation strategies. Strengthening of the IJC in this regard would also allow respective governments to better understand the impacts of climate change on water security, potentially deepening understandings of current and future vulnerabilities.

Although these shared waters may be a source of challenge and disagreement, they may also provide an opportunity for cooperation and negotiation. In order to mitigate the negative effects of climate change on future water governance, Canadian and U.S. governments should work together to improve old treaties, alter water

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[76] Kevin Ma. "Canada-US Relations and the Devils Lake Dispute." In *Canada's international policies: agendas, alternatives, and politics*. Brian W. Tomlin, Fen Osler Hampson, and Norman Hillmer eds., (Don Mills, Ont.: Oxford University Press, 2008), p. 327.
[77] Ibid, 327.
[78] Ibid, 318-319.
[79] Ibid, 328.
[80] Ibid, 328.
[81] Ibid, 328.
[82] Heather Cooley, et. al., *Understanding and Reducing the Risks of Climate Change for Transboundary Waters*, (Oakland, California: Pacific Institute, 2009), 9-10.

treaties that require a minimum flow, develop new treaties, ensure acceptable water quality, and strengthen institutional arrangements. These recommendations will not only enhance Canada's water security, but also enlarge the range and effectiveness of measures available for prevention and recovery if tensions concerning water security should arise.

Water Trade

Water is an essential element of life and survival, yet trade in water is controversial. While some advocate for water commercialization, others claim that water should remain a public good or shared entity. This report asserts that water should be considered a human right; therefore, water and its role in international trade will be evaluated based on this approach. As water quantities decrease in other areas of the world as a result of climate change and demand growth, this triggers an increasing international demand for water resources.[83] From a market perspective, increasing scarcity suggests that potential gains from trade of this valuable resource should be sought.

Proponents of this view claim that environmental goods such as water will be more efficiently allocated if they are considered economic goods.[84] This view of water allocation, in their opinion, addresses both concerns of environmental degradation and inefficient use of resources concurrently.[85] Water priced at full economic and environmental cost enables this increasingly scarce resource to be allocated to its highest-value uses, according to proponents of this view. They point to the failure of governments and aid agencies to secure the goal of universal water supply as a result of the low efficiency and low levels of cost recovery of public utilities during the International Water and Sanitation Decade (1981-1990).[86] Advocates of market environmentalism believe that the commercialization of water is the best outcome for society.

Opponents of market environmentalism and the commercialization of water believe that access to sufficient quantity and quality water is a human right. According to them, water is a "non-substitutable resource essential for life".[87] As a result, they assert that water should be recognized internationally as a human right, thus forcing states to provide this right and eliminate private sector involvement.[88] This is the stance that the Canadian government should adopt, we argue. Involvement of the private sector in water allocation is "incompatible with guaranteeing citizen's basic right to water" because it introduces unreliable logic of

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[83] Saule Bakenova, "Interpreting the Emergence of Water Export Policy in Canada," *Politics & Policy* 36.4 (2008): 680.
[84] Karen Bakker, "The 'Commons' Versus the 'Commodity': Alter-globalization, Anti-privatization and the Human Right to Water in the Global South," *Antipode Journal Compilation* (2007): 432.
[85] Ibid, 234.
[86] Ibid, 437.
[87] Ibid, 432.
[88] Paul Moist, "Communities, Not Corporations: The Clear Choice for Canada's Water," *Canadian Dimension* 40.5 (Sep./Oct., 2006): 38

the market into water management.[89] The government of Canada, unlike the private sector, has the ability to ensure sustainable water management through the use of national coordination efforts. National data collection of current resources and projected changes as a result of climate change are more easily facilitated by a Federal government responsible for the wellbeing of Canadian citizens than by private companies answerable to shareholders and with a goal of profit over sustainability. An obstacle here is that water management is primarily in the hands of provincial governments, and each takes a different approach to water rights in their territory. The image below displays the water rights policies of the various provinces and territories. [90]

[89] Bakker, 437.

[90] FIT-FIR is based on principles of prior appropriation, which gives the licensee exclusive rights to use water in a system of seniority based on the age of license. Under common law, individuals who own or occupy land beside lakes and rivers have the right to the natural flow of the water adjacent or through their property, unchanged in quantity or quality. The provinces have the overarching responsibility to administer water and supervise its allocation. As a result, their legislative jurisdiction over water must be exercised in a manner equitable to all. Civil Law in Quebec states that water is not owned by anyone, but rather is common to all, therefore the province takes on a guardianship role to ensure water remains a common good.

Canada's Constitution Act does not refer directly to responsibilities pertaining to water resources. However, as the provinces and territories exercise direct control over the natural resources within their borders, the constitutional authority for water belongs primarily to them.[91] While the provinces maintain the chief role in water management, the federal government shares this responsibility with the provinces on issues pertaining to authority over fisheries, navigation, transboundary disputes, federal lands, Aboriginal matters, agriculture, health, and environmental protection.[92] One of the key federal documents on water management is the 1987 Federal Water Policy, which has the overall objective of encouraging "the use of freshwater in an efficient and equitable manner consistent with the social, economic, and environmental needs of present and future generations".[93] In order to ensure that water remains a public good, it is essential that the government of Canada maintains their position on water as such and never treats it as a commodity. The government must also take steps to ensure that provincial governments share their vision of water as a public good. An important reason that Canada and the provinces should maintain the public good status of water in Canada is for national security purposes. International trade liberalization can create challenges to a state's sovereignty, environmental stability, and property rights over a resource, and water is no exception.[94] Furthermore, the Canadian government should take an interest in preserving its water resources, as many Canadians consider their abundance of water as part of their country's identity.[95]

It is important for Canada to ensure that water, one of its most precious resources, is not exploited. However, "domestic legislation prohibiting water exports would contradict Canada's international obligations and would appear unilateral."[96] A concern with this policy position is the reaction of the United States, as an important member of the North American Free Trade Agreement (NAFTA), and whether any such legislation could be overturned if it clashed with free trade agreements.[97] In 1993, a joint public statement was issued by Canada, the United States, and Mexico affirming that NAFTA did not establish rights to water resources in any country party to the agreement and that water in its natural state (i.e. lakes, rivers, reservoirs) is not a good, and may therefore not be subject to the terms of any trade agreement.[98] Canada and Mexico are two of the United States' largest trading partners; in 2005 Canada provided 33 percent of America's total energy imports and close to 100 percent of the country's electricity imports.[99] In 1993, Canada drew up a

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[91] National Roundtable on the Environment and the Economy, *Changing Currents: Water Sustainability and the Future of Canada's Natural Resource Sectors,* (Ottawa: NRTEE, 2010), 46.
[92] Ibid, 47.
[93] Ibid, 48.
[94] Bakenova, 681.
[95] Ibid, 682.
[96] Ibid, 687.
[97] Moist, "Communities, Not Corporations," 38.
[98] Bakenova, "Interpreting the Emergence of Water Export Policy in Canada," 687.
[99] Chappell Lawson, "Raising the Salience of Mexico and Canada," *The Audit of the Conventional Wisdom: MIT Center for International Studies* 5.3 (Apr., 2005): 2.

declaration that would prevent water exports provided the state never allowed water to enter into commerce and become a good or a product.[100] The Canadian government must be careful not to violate the terms of this declaration, despite possible pressures from its neighbour to the south. Any such violations could set daunting precedents for the future, like the 2010 NAFTA challenge against the Government of Newfoundland and Labrador by one of the world's largest paper mills, AbitibiBowater.[101] The Government of Canada should protect its citizens' right to determine how their water resources are managed. This might be achieved by ensuring international trade agreements do not allow for any other party to gain rights to Canada's natural water resources, and by preventing situations where Canada would be obliged to exploit its water commercially.[102]

In addition to the 1993 declaration, Canada has worked to protect its water resources under the 2002 amendment to the International Boundary Waters Treaty Act (IBWTA), which prohibits bulk removal of freshwater for all purposes, including export, from the boundary basins shared by Canada and the United States.[103] However, further action related to bulk water exports are necessary because the World Bank expects water to be transferred around the globe as oil is now. The economic feasibility of bulk water withdrawals is one of the only things stopping bulk water transfers from occurring at present; however, improvements in technology may render these transfers more practical in the future.[104]

Despite being a provincially managed resource, this strategic resource also has many implications for national security. The IBWTA remains a relatively weak tool in the protection of Canadian sovereignty over water resources as economic and political interdependence create increased pressure for the commoditization of water. Furthermore, as technological innovations in bulk water transfers progress, actual water trading practices may be realized.[105] It is important that Canada maintain its opposition to bulk water transfers and water exports because "a poor track record on water withdrawals issues may jeopardize attempts by states and provinces to block it" in the future, is such actions become more feasible.[106]

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[100] Bakenova, "Interpreting the Emergence of Water Export Policy in Canada," 687.
[101] "Water: A Budget for the Rest of Us," *Canadian Center for Policy Alternatives* (2012): 153. In 2010, the federal government settled for $130 million dollars a NAFTA challenge brought against the Government of Newfoundland and Labrador by AbitibiBowater, headquartered in Montreal, QC (now called Resolute Forrest Products and considered one of the largest pulp and paper mills in the world). The firm claimed that part of this amount was to include compensation for provincial water rights it cannot legally own in Canada, setting a dangerous precedent. Excluding water in trade agreements will avert threats to Canada's water and costly NAFTA challenges. This case demonstrates the importance of strengthening domestic legislation to secure water as a public good, since both Canadian provinces and international members of NAFTA may challenge the status of water under the agreement.
[102] Moist, "Communities, Not Corporations," 40.
[103] Bakenova, "Interpreting the Emergence of Water Export Policy in Canada," 676.
[104] Ibid, 681.
[105] Ibid, 688.
[106] Ibid, 681.

Given the costs and inefficiencies of water transfers, virtual water[107] may be the best route for Canada to promote water as a human right. Virtual water is believed to be a successful means for water deficient economies to resolve shortfalls.[108] Virtual water imports should not be confused with water imports; instead, they are actually food or material good imports.[109] Actual water imports may provide a region with water to drink or use in agriculture or production of goods and services. They can help to reduce a water deficit by providing the resources to manufacture and sell products, grow and export crops, and create jobs within the nation. Virtual water associated with food imports provides a region with food or goods, but not the actual water. Such imports often result in a faster population growth rate without a matching supply of water. Virtual water also brings challenges, however. They maintain the need for increased food imports in the future, which actually increases the water deficit.[110] Furthermore, lower levels of national production, changes in local food varieties, and related price and employment shocks may all occur as a result of high levels of virtual water trade.[111] Canada and other virtual water exporters have considerable influence in virtual water markets and they should therefore act cautiously when drafting policies pertaining to the commercialization of water.

Since water is a non-substitutable resource, and is essential for life, Canada should recognize a human right to water. Nationally, Canada should make access to adequate and safe drinking water a constitutional right. On the international level, Canada should encourage the United Nations Declaration of Human Rights (UNDHR) to explicitly include water as one of the human rights outlined in the document. As a statute of international law, water's inclusion in the UNDHR would create an obligation for all states that are signatories of this document to provide this right to their citizens. Furthermore, Canada must ensure that water is never treated as a good or product, because this would be detrimental to Canada's future stance against water commercialization. Canada must also continue to work to exclude water from all international trade agreements, including NAFTA. Since the majority of Canadian water is managed provincially Canada must also encourage its provinces to refrain from bulk water removal or transfer, because this might hinder Canada's claim to water as a public good rather than a commodity.[112]

Canada must acknowledge that virtual water is just that, virtual. While it is a frequently used alternative to bulk water transfers today, it has many implications

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[107] Virtual water is most often defined as "the water needed to produce agricultural commodities" but may also include water used in the production of a good or a service.[107] In reality, there is nothing 'virtual' about virtual water except when it is traded. Virtual water is real water needed to grow food or used in the manufacture of a good. It is only virtual for the state receiving the commodity that this water was used to produce.
[108] Merrett, "Virtual Water and the Kyoto Consensus," 541.
[109] Ibid, 541.
[110] Ibid, 541.
[111] Scott Vaughan, "The Greenest Trade Agreement Ever? Measuring the Environmental Impacts of Agricultural Liberalization," in John J. Audley et. al. Eds., *NAFTA's Promise and Reality: Lessons From Mexico for the Hemisphere* (Washington D.C.: Carnegie Endowment for International Peace, 2004): 63.
[112] Bakenova, "Interpreting the Emergence of Water Export Policy in Canada," 690.

for the importing state which renders it an undesirable solution to water insecurity. Canada must promote global adaptation to climate change, particularly pertaining to water security. This action will help reduce international demand for Canada's water supply, and therefore reduce pressure on Canada to exploit its water commercially.

(2) AGRICULTURE

Although North America is relatively food secure, the impact of climate change on Canadian and American food production capabilities will have significant implications for North America's trade market. In regards to Canadian agriculture, farmland in the Prairies is expected to be most significantly affected by climate change. Projected temperature increases in the Prairies will increase the likelihood of heat waves that could contribute negatively to maize and wheat yields, especially in the South.[113] Precipitation patterns in the Prairies are also expected to change, with rainfall increases during the early spring and decreases during the summer.[114] These changes in rainfall may potentially delay the planting season in spring due to flooding, and limit water availability during the growing season through drought. More frequent and more intense droughts could have a potentially devastating impact on Canada's agricultural sector. The 2001/2002 Prairie drought resulted in losses to crop sales worth $0.9 billion in 2001, and $2.3 billion in 2002.[115] Additionally, winter grains may fail more often due to decreased snowfall, since winter crops generally depend on snow cover for protection from cooler temperatures in February and March.[116]

The American Midwest is projected to experience a significant decrease in agricultural productivity as water demand increases and water supply decreases. Climate change projections for the Midwest indicate a general decrease in water availability for the region's agricultural sector.[117] Winter and spring are expected to be wetter, but summer is expected to be drier in both high and low-emission scenarios.[118] The frequency and intensity of drought in the Midwest is expected to increase with climate change; the Union of Concerned Scientists anticipates that drought will cause the value of rain-fed agriculture to decrease by as much as 25% by 2050.[119] The NCADAC 2013 Draft Report confirms this trend, and adds that more extreme precipitation will also put stress on rain-fed agriculture by contributing to the deterioration of crop soil.[120] Summers will experience more rapid evaporation,

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[113] Surendra N. Kulshreshtha, "Climate Change, Prairie Agriculture, and Prairie Economy: The New Normal," *Canadian Journal of Agricultural Economics* 59 (2011): 24.
[114] Ibid, 23.
[115] Ibid, 32
[116] Ibid, 24.
[117] Midwest: Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, Ohio, and Missouri.
[118] Union of Concerned Scientists, "Minnesota," *Confronting Climate Change in the U.S. Midwest*, July 2009, 6.
[119] Ibid, 9.
[120] National Climate Assessment Development Advisory Committee, *National Climate Assessment,* Draft, (Washington D.C.: NOAA, January 2013), 227.

which will decrease soil moisture, thus negatively impacting crop productivity.[121] The increasing evaporation rate is also expected to lower the water levels of the Great Lakes, which will over time decrease the amount of water available for farmland irrigation in the region.[122] In addition, rainfalls are expected to be more intense in the Midwest, which will increase the risk of flooding in the spring and in turn could delay the planting season for many early crops.[123]

Agriculture in the Great Plains is also expected to be negatively affected by changes in water availability over the next few decades.[124] Although the entire region is expected to experience increases in mean temperature, the region is less consistent with regards to its projected changes in precipitation. Generally, the Northern states will be wetter, and the Southern states drier.[125] Although some areas of the region are expected to receive more rainfall, it is unlikely these increases will be able to offset the effects of increased evaporation and depleting groundwater. The primary freshwater resource for the Great Plains is the High Plains aquifer, which supplies drinking water to 80% of the region's population and irrigates 13 million acres of farmland.[126] At present, the rate of depletion of water in the aquifer already surpasses the recharge rate, a situation that will only be exacerbated by increasing water demands.[127] As water demands continue to rise and water supply from the aquifer and rainfall continue to decline, the US will have to seek ways to adapt to water stresses that will be heightened with climate change.

Due to the nature of the global market, challenges to US food production posed by climate change will have economic implications for Canada. In some instances, the globalized food market can weather the challenges posed by food shortages in different regions, since there are always multiple states growing the same crop. However, the interconnectedness of the world's trade market also has the potential to cause a ripple effect when one state's food productivity becomes compromised by climate change.[128] As a result of the 2012 southern U.S. drought for example, global wheat prices rose significantly as evidenced by the UN's Food Price Index increasing by 6.2% in July 2012, ending several consecutive months of steady decline.[129] As drought becomes more frequent and more intense in North America, the implications for the global grain market will become increasingly significant. In response to decreasing agricultural productivity in North America, Canada should adopt national

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[121] U.S. Global Change Research Program, *Global Climate Change Impacts in the United States*, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009, 121.
[122] Ibid, 119.
[123] Ibid, 120.
[124] Great Plains: Montana, North Dakota, Wyoming South Dakota, Nebraska, Eastern Colorado, Kansas, Eastern New Mexico, Oklahoma, Central Texas.
[125] National Climate Assessment Development Advisory Committee, *National Climate Assessment,* Draft, January 2013, 234.
[126] U.S. Global Change Research Program, Global Climate Change Impacts in the United States, 124.
[127] Ibid. Richard G. Taylor et al. "Groundwater and Climate Change," *Nature Climate Change*, November 2012, 323.
[128] National Climate Assessment Development Advisory Committee, *National Climate Assessment,* Draft, January 2013, 243.
[129] National Australia Bank Group, Implications of the U.S. Drought, August 2012, 3.

policies that offer the best situation for Canadian farmers who are attempting to adjust to climate change impacts.

The uncertainties posed by climate change require a Canadian agricultural policy that is flexible to fluctuations in crops prices, availability, and demand. National policies have the potential to provide Canadian farmers with bargaining capabilities and insurance, but they also have the potential to restrict economic freedoms and limit the economic maneuverability of Canadian farmers. The Canadian Wheat Board (CWB) demonstrated the ability both to help, and to hinder Canadian farmers.[130]

The Southwest region of the United States spans almost a quarter of the country, from the Pacific Coast to the Southern Rocky Mountains.[131] The Southwest's topography is mountainous, with some of the country's highest latitudes and lowest valleys, and some of its wettest and driest climates.[132]According to the IPCC's Fourth Assessment Report, the greatest warming across North America will be experienced at high latitudes during winter, and during the summer in the Southwest U.S.A.[133] According to the US Global Climate Research Program's most recent Impact Report, the rate at which average temperature is increasing in many areas the Southwest is significantly higher than the global average, one of the most rapid in the country.[134] Most models forecast that a global increase in average temperature between 2-5 degrees C will cause an increase in the frequency and severity of droughts in regions prone to them.[135] The Southwest is naturally prone to both drought and extreme precipitation events: the 1980's and 1990's were unusually wet decades, while the 1950's and 1960's were unusually dry ones. Analysis of the changes is Colorado River flows since 1900 indicate that drought is a common feature of the region. Other, longer term investigations of similar indicators conclude that so called "megadroughts" have occurred periodically over the past two thousand years, most recently at the turn of the sixteenth century.[136]

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[130] Until 2012, the CWB was the only Canadian company with the jurisdiction to trade Canadian wheat in foreign markets.[130] The CWB would sell Canadian wheat to foreign buyers and then return the revenues to Canadian farmers minus marketing costs. The CWB was also capable of offering subsidized credit to farmers, helping them increase their farm's productivity and efficiency by developing more mechanized technology.[130] Due to the size and political backing of the CWB, the board helped the Canadian wheat industry thrive and reach distant markets. On the other hand, some Canadian farmers have criticized the CWB for inhibiting their individual growth and limiting their ability to compete with new technologies and market structures that were being adopted by rising powers including India, Russia, Brazil, and Argentina. Farmers in favour of the CWB's dismantling have argued that they no longer need Federal protection from global price spikes or international competition.[130] However, with the global wheat demand growing and climate change creating an increasingly unpredictable market, Canada needs to adopt a policy that can keep Canadian farmers protected without undercutting their economic freedoms. If the CWB were revamped, rather than dismantled, in order to incorporate voluntary entry and member participation, it might help Canadian farmers stay relevant in a transforming global food market.

[131] Composed of California, Arizona, Colorado, Nevada, New Mexico, Utah, and a small part of South Western Texas.

[132] U.S. Global Change Research Program, *Global Climate Change Impacts in the United States*, 129.

[133] IPCC et al, Climate Change 2007: Fourth Assessment Report, 14.21.1

[134] U.S. Global Change Research Program, *Global Climate Change Impacts in the United States*, 129.

[135] "United Nations launches concerted push for effective drought policies," Media Center, Food and Agriculture Organization of the United Nations, http://www.fao.org/news/story/en/item/171336/icode/

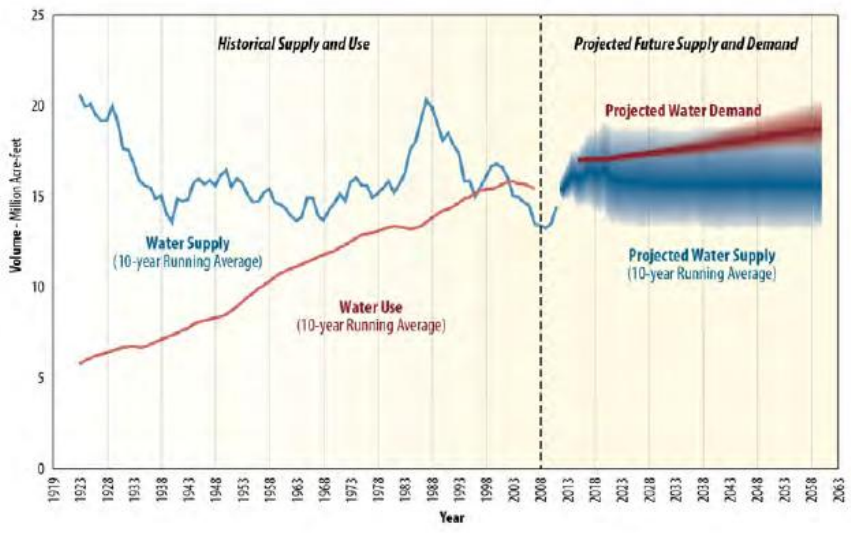
[136] Ibid, 129-130.

The Colorado River basin, the major source water for agriculture in the Southwest, has experienced decreased stream discharge since 1950.[137] Rainfall across the region is projected to decrease.[138] If this is the case, flows of runoff water from snowpacks that feed the Colorado River will be further reduced by the temperature increase exactly when they will be most needed to make up for unevenly distributed rainfall. Combined with the greater loss of water through evaporation in higher temperatures, in the arid areas of the Southwest, this will very likely mean an increased general state of water insecurity, and very likely increased frequency and severity of droughts.[139] According to the UN's Food and Agriculture Organization, drought is by far the most destructive of all natural hazards, affecting more people worldwide than cyclones, floods, and earthquakes combined.[140]

Absolute demand for water resources has steadily increased in the American Southwest since the mid twentieth century, driven by steady regional population growth and consumption increases. The Southwest is already especially water-stressed because of this. The 2012 Colorado River Basin Supply and Demand Study predicts that by 2060, there will be an approximate 3.2 million acre feet (maf) deficit in regional water supply.[141] (See Figure 1.)[142]

Figure 1.

Historical Supply and Use[1] and Projected Future Colorado River Basin Water Supply and Demand[1]



[1] Water use and demand include Mexico's allotment and losses such as those due to reservoir evaporation, native vegetation, and operational inefficiencies.

California, the most populous American state, exemplifies the regional

[137] IPCC et al. *Climate Change 2007: Fourth Assessment Report*, 14.2.1.
[138] U.S. Global Change Research Program, *Global Climate Change Impacts in the United States*, 143.
[139] Arriaga-Ramírez et al, "Regional trends of daily precipitation indices in northwest Mexico and southwest United States," *Journal of Geophysical Science* 115. 14 (2010): 4.
[140] "United Nations launches concerted push for effective drought policies," Media Center, Food and Agriculture Organization of the United Nations.
[141] U.S. Department of Interior, *Colorado River Basin Supply and Demand Study*, Executive Summary, ES-6.
[142] U.S. Department of Interior, *Colorado River Basin Supply and Demand Study*, Executive Summary, ES-7.

dynamics outlined above, and is uniquely important within the United States and for Canada in terms of trade in agricultural goods. Farming and ranching are important sources of industry and income in California, producing half the country's domestic supplies of fruits, vegetables, and nuts.[143] The high water intensity of California's staple crops accounts for the fact that, as of 2005, the agricultural sector consumed 80% of state water withdrawals. Urban centers increasingly require a greater share of the state's water resources, creating a tug-of-war in which "the agriculture industry is hardest hit."[144]

Unfortunately, California's water security and food security problems are Canada's water security and food security problems. Canada is the single largest external market for California produce; typically Canada consumes approximately twenty-five percent of the states' total net export of produce per year.[145] In 2007, Canadian's spent 1.5 billion dollars on fresh produce from California: lettuce, spinach, strawberries, grapes, citrus fruit, and many other varieties.[146] If solutions are not forthcoming, Canadians risk paying more as yields decrease and prices rise.

Adaptation and water management measures are necessary first and foremost in the all-important Colorado River basin. Currently, the process by which the seven Southwestern states share the river's waters is outlined in the Colorado Compact, negotiated in the 1920's.[147] Since then, runoff has decreased markedly, and an updated agreement is urgently needed to effectively manage how this important resource is shared. If the situation in California and the Southwest are not addressed, Canadians could end up paying more for their produce as yields decrease and prices increase.

In 2005, the seven Colorado River states began a dialogue with the US Secretary of the Interior on establishing common guidelines for dealing with water scarcity and drought.[148] In 2007, they signed the Colorado River Interim Guidelines for Lower Basin Shortages, an agreement to "plan for shortages, implement closer coordination of operations... deal with further challenges such as climate change and deepening drought, implement operational rules for a long – but not permanent – period...."[149] In December 2012, they released the Colorado River Basin Supply and Demand Study, discussed above, which outlines potential solutions to the projected 3.2 maf supply deficit.[150] The study represents a commendable and concerted effort on behalf of the state and federal governments to develop climate change adaptation

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143 "University of California Tackles Water Crisis," *Resource* 17 (2010):20-21.

144 Ibid, 21.

145 Brenda Carol, "Canadian and US Produce Grower-Shippers Gather to Enhance Trade North of the Border," *Western Farm Press* 37 (2009): 20.

146 Carol, 22.

147 Global Change Research Program, *Global Climate Change Impacts in the United States*, 130.

148 Committee on the Scientific Bases of Colorado River Basin Water Management, National Academies of Science , *Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability*, 2.

149 U.S. Department of the Interior, *Record of Decision: Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead*, December 2007, 1-2. http://www.usbr.gov/lc/region/programs/strategies/RecordofDecision.pdf.

150 U.S. Department of Interior, *Colorado River Basin Supply and Demand Study*, Dec. 2012. Executive Summary, ES-6.

strategies in cooperation with the public, and environmental interest groups.

In California, the Bay Delta Conservation Plan (BDCP) is the California Natural Resources Agency's plan to manage the Sacramento-San Joaquin Delta, an extremely important source of water for central and southern California, feeding three million acres of irrigated farmland and 25 million people.[151] The plan is designed to manage competing urban and agricultural interests, to improve the reliability of water supplies and water quality, and to reduce risks to water security from climate change and natural disasters, while conserving biodiversity, particularly of wild fish stocks.[152] While the plan is still in the drafting stages, its cooperative approach, involving the public, state, federal, and municipal governments, as well as interest and environmental advocacy groups presents a positive example for major water resource management.

To conclude, while the current state of drought and generalized water insecurity in the Southwest is currently reaching critical proportions, with effects for Canadians concerning trade in agriculture, the state and federal authorities have shown commendable initiative in encouraging research and cooperating to develop strategies for adapting to the effects of climate change on water and food security in the region.

(3) ENERGY

In analysing the production of agriculture in North American, it is important to consider the factor that facilitates agricultural production—energy. In the context of climate change, the interdependence between energy production and water resources is vital to the global economy and environment. Climate change is largely caused by greenhouse gas emissions (GHGs), which are the by-products of carbon intensive energy sources. However this relationship is mutually dependent as energy is also required to pump and treat water for human use. This has important implications for the climate change-constrained future. Energy and water demand are both expected to increase as global populations increase and as industrial development evolves. While projections of water availability are uncertain, as outlined above, most scholars expect climate change to increase water scarcity in certain regions of North America, and this will have repercussions for human development and energy production. In examining the water-energy nexus within the context of climate change, this report analyses four key North American energy

[151] Dave Puglia, "State Reveals First Chapters of Bay Delta Conservation Plan," *Western Growers* March 19, 2013, accessed March 23, 2013. http://www.wga.com/blog/2013/03/19/state-releases-first-chapters-bay-delta-conservation-plan.

[152] California Department of Water Resources (CDWR), *Bay Delta Conservation Plan: Environmental Impact Report/Environmental Impact Statement*, Draft, CDWR/U.S. Bureau of Reclamation/U.S. Fish and Wildlife Service/National Marine Fisheries Service, March 2013, 1-2. http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/BDCP_Chapter_1_-_Introduction_3-14-13.sflb.ashx.

sources: Synthetic Crude Oil (Alberta), Shale Gas, Bio-Fuels (Ethanol), and Hydro-Electricity. In choosing to focus on the production of these respective energy sources, this report recognizes that there will be a continued dependence, and growth in each of these sectors in the future. Increased production will require high levels of freshwater in order to facilitate development. The purpose of this section is to identify the water requirement of each energy type and to assess how climate change induced water scarcity will impact the North American energy industry. To guide Canadian policy makers, each section below will provide recommendations with the aim of mitigating future negative impacts.

Oil Sands

Development in Alberta's oil sands has generated tremendous wealth for the province and for Canada. But it has also drawn widespread condemnation. The reason for the criticism is the environmental consequences associated with bitumen mining and processing. Although the GHG emissions from oil sands synthetic crude depend on the extraction method (surface mining vs. in-situ recovery), both methods produce a more carbon-intensive fuel than conventional crude oil. In terms of 'wheel-to-wheel' emissions that take into account extraction, refining and transportation, conventional fuel is estimated to produce 250-280g of CO_2/km, while bitumen produces 260-320g of CO_2/km and 320-350g of CO_2/km for surface mining and in-situ respectively.[153] Despite the environmental drawbacks associated with oil sands development, the benefits they provide to the Canadian economy and energy security ensure that they will continue to be a part of this country's energy mix.[154] While this means that development will proceed, this must be done in the most sustainable manner possible – not only in terms of GHG emissions, but also in terms of water use and impacts, which are more central to the discussion at hand.

According to Canada's National Energy Board, oil sands production accounted for approximately 54% of the country's total crude production in 2010.[155] However, by 2035 total oil sands production is expected to triple, reaching 5.1 million barrels per day and increasing its share to approximately 84% (See Figure 1 Below for Trends).[156] Not only will Canada be producing a more carbon intensive fuel, it will

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[153] N.C. Swart and A.J. Weaver, "The Alberta Oil-Sands and Climate," *Nature Climate Change* (2012), 3. Surface mining and in-situ recovery represent two fundamentally different methods of extracting and processing bitumen into synthetic crude. Surface mining involves removing the oil 'sands' and transporting them to a processing plant where the oil is removed from the sand and clay through a water-intensive process. In-situ is a method of steam-assisted gravity drainage that pipes steam into underground bitumen reserves. The steam is used to heat the bitumen and separate the oil from the sand and clay; the oil is then pumped back up to the surface via another pipe.

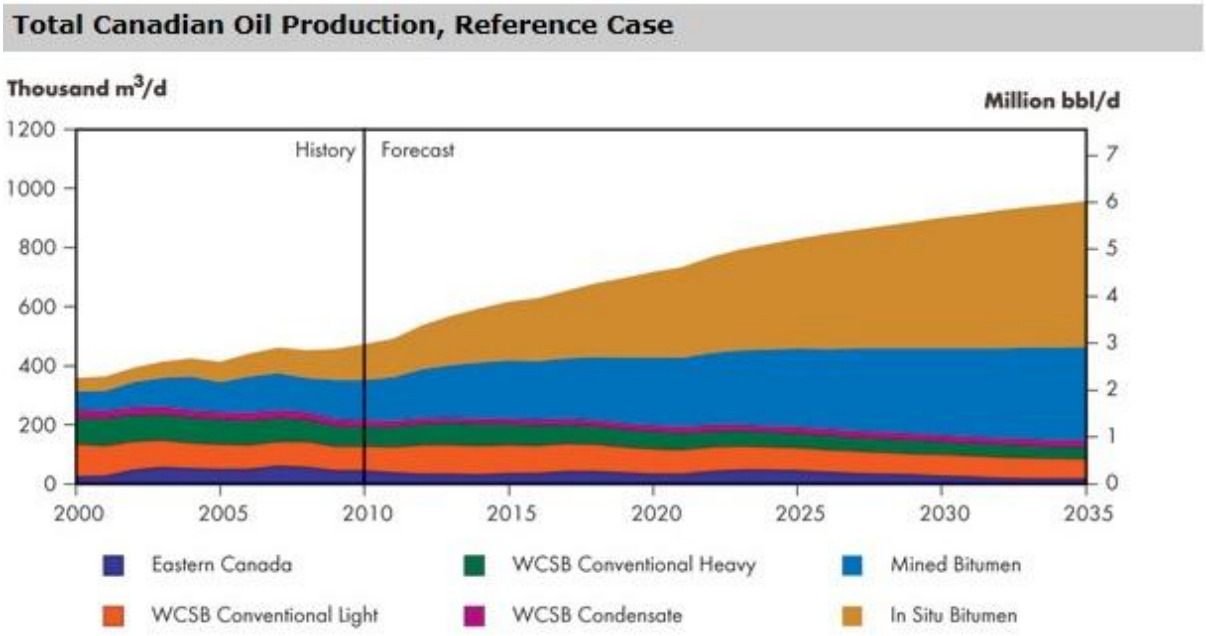
[154] Despite the perceived economic benefits of oil sands, there are some who argue that natural resource production inevitably leads to a 'resource curse'. See: Shannon M. Pendergast et al., "Corruption, Development and the Curse of Natural Resources," *Canadian Journal of Political Science* 44, no. 2 (June 2011): 415. They note that while the 'curse' is not as profound in Canada, manufacturing sector employment has declined significantly as a result of increased resource extraction and the higher Canadian dollar that accompanied it.

[155] National Energy Board of Canada, "Canada's Energy Future: Energy Supply and Demand Projections to 2035 – Crude Oil and Bitumen Highlights," January 15, 2013, http://www.neb-one.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgyftr/2011/fctsht1134crdl-eng.html.

[156] Ibid.

also be consuming more water to do so, as bitumen production requires more water for processing than conventional fuel. The average barrel of oil sands synthetic crude consumes 2.5-4 times more water than a barrel of conventional crude.[157] However, the link between oil sands production and water is not restricted to the amount consumed; rather, there are numerous associated water quality impacts.[158] Thus, the water requirements of oil sands mining, and the waste water produced pose hazards that threaten water security in its conception as a basic human right.

Figure 1: National Energy Board of Canada Oil Production Projection Trends, 2010-2035[159]



Given the reality that oil sands development will continue and will likely expand rapidly, it is necessary to evaluate the state of regional water resources. Current oil sands operations withdraw approximately 170 million cubic metres

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[157] United Nations World Water Assessment Programme, *Managing Water under Uncertainty and Risk: The United Nations World Water Development Report 4*, 2012: 53-54, http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/wwdr4-2012/ (accessed December 2, 2012). The range given represents the different water requirements of in-situ recovery and surface mining. The Canadian Association of Petroleum Producers assess the water usage of in-situ to be 0.4 barrels of freshwater per barrel of oil (in-situ is also able to use underground saline water resources), while surface mining operations consume 3.1 barrels to produce one barrel of oil.

[158] The process of separating the bitumen from the 'sand' requires substantial quantities of water, but much of this is contaminated by toxic hydrocarbons present in the oil. Thus, a great deal of the water withdrawn becomes unfit for most human and industrial purposes and is then deposited into tailings ponds with the remaining sand, clay and oil residues. Although tailings ponds are primarily associated with surface mining, in-situ operations present similar risks to water supplies. While less water is required and, therefore, less waste produced, most of this wastewater remains underground where it can contaminate groundwater supplies used by local populations and businesses.

[159] National Energy Board of Canada.

annually, but with projected expansions expected to triple output, water use will likely increase substantially.[160] Although current levels are considerably less than the 652 million cubic meters that mining companies are licensed to withdraw each year, as production expands mines will be forced to use larger quantities.[161] As these withdrawals alter the natural flow of the river, there are likely significant consequences for local ecosystems. Moreover, as more and more water is withdrawn, populations downstream are increasingly likely to notice the effects. While the exact effects of climate change on this part of Alberta (the Lower Athabasca River Basin) cannot be ascertained, general trends can be deduced.[162] Natural Resources Canada's analysis of water resources in the Prairies projects changes in annual stream-flow, including the potential for large reductions in summer flow; moreover, severe regional droughts will become more likely due to climate change.[163] This is substantiated by the general expectation that melting glaciers will result in long-term flow reductions in rivers fed by glaciers. Given that the Athabasca River is glacier-fed, it could suffer decreased flow due to changes in glacial melt; moreover changes in precipitation and increased evaporation caused by climate change could further decrease water availability.[164] In this sense, oil sands operations and surrounding communities will experience the challenge of rising demand for water, coupled with decreasing supply. This raises the possibility that severe shortages could force a compromise between energy sector needs and the human right to water.[165]

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[160] Canadian Association of Petroleum Producers, "Water Use in Canada's Oil Sands," 1, http://www.capp.ca/getdoc.aspx?DocId=193756.

[161] Pembina Institute, "Oil Sands Water Impacts," http://www.pembina.org/oil-sands/os101/water.

[162] Elizabeth Dowdeswell et al. (Oil Sands Advisory Panel), "A Foundation for the Future: Building an Environmental Monitoring System for the Oil Sands, A Report Submitted to the Minister of Environment," December, 2010, http://www.ec.gc.ca/pollution/E9ABC93B-A2F4-4D4B-A06D-BF5E0315C7A8/1359_Oilsands_Advisory_Panel_report_09.pdf. This report specifically addresses the water quality impacts of oil sands development, but it briefly discusses the effects of climate change on the Athabasca River Basin. The authors question whether or not current water licensing practices (with various industries) are sustainable with the projected changes in surface flow, although they do not discuss the projections themselves. In dealing with water quality impacts, this report assesses oil sands water use and the extraction process' environmental consequences. Tailings ponds created by surface mining processes, are a major topic of discussion. Dowdeswell et al. also note that the effects of in-situ recovery operations on groundwater resources are not yet well known and that this merits more attention as oil sands development is increasingly moving towards an in-situ dominant future. One final consideration they address concerns the impacts of oil sands mining on the Athabasca River itself. They note that these impacts cannot yet be accurately quantified, as the River flows through the oil sands region and is exposed to the related toxins naturally; thus, it is difficult to differentiate between natural and anthropogenic exposure (due to oil sands development). This too, is an area that deserves greater monitoring capabilities.

[163] Natural Resources Canada, "Water Resources," October 2, 2007, http://www.nrcan.gc.ca/earth-sciences/products-services/publications/climate-change/climate-change-impacts-adaptation/493.

[164] Allison J. Squires et al., "An Approach for Assessing Cumulative Effects in a Model River, the Athabasca River Basin," *Integrated Environmental Assessment and Management* 6, no. 1, 120.

[165] Demand on the Athabasca River is not limited to population requirements and the oil sands industry; Squires et al. (see page 120) note that demand for its water is increasing due to development of other local industries. Among these are agriculture, forestry, pulp and paper, coal mining, as well as conventional oil and natural gas operations. The demand for this water source alone makes it particularly vulnerable to water shortages that result from climate change related water impacts.

Although it is clear that oil sands development will continue to expand, it is imperative that governments approve projects with an eye to the future. This includes taking into account how changes in water supply induced by climate change will impact production, as well as how oil sands' withdrawals will affect the quality and quantity of water available to downstream communities. In order to develop the oil sands sustainably, with respect to water supplies, more research and better information sharing is necessary.[166] This includes research concerning water resource projections as well as continued monitoring of downstream water quality and 'instream flow needs'. The Alberta Government has already begun to assess 'instream flow needs' for the Athabasca River as part of its "Water Management Framework" however these will continue to evolve as populations and industries grow.[167] Ensuring access to up-to-date and accurate scientific information will help to develop the energy industry, while maintaining water security. However, perhaps a more effective way to reduce oil sands' water use would be to place greater restrictions on total water withdrawals.[168] Such a move would force companies to adopt less water-intensive extraction methods such as in-situ recovery, or even encourage them to innovate and develop even less intensive processes.[169] This would have the dual effect of reducing waste water while simultaneously increasing the quantity available to other industries and populations that use the Athabasca River Basin. A final recommendation would likely involve both federal and provincial governments, and would involve the removal of subsidies – direct, expenditure, and tax subsidies – currently available to oil sands operations.[170] Although such a move could marginally

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[166] This view is shared and expanded upon by the Oil Sands Advisory Program. They note the existence of numerous research and monitoring programs funded by various levels of governments, industry leaders and nongovernmental organizations, but argue that information management and sharing is inadequate. For example, there is no central database that houses all the information, rather the various reports are all separate and the relevant information is often difficult to find, making comparisons difficult to make, and patterns and trends hard to deduce.

[167] Alberta Ministry of the Environment and Fisheries and Oceans Canada, "Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River," February 2007, http://environment.alberta.ca/documents/Athabasca_RWMF_Technical.pdf.

[168] As stated in note 76 above, uncertainties over water supply in the climate change-constrained future call into question the sustainability of current water management practices. It is likely that increased water scarcity will result in reduced supply for energy producers. As Dowdeswell et al. note, during periods of low flow, the Alberta Government restricts the oil sands' share of water from the Athabasca River to 1.3% of average annual flow, down from 3% in periods of normal flow (see Exhibit B on p. 11).

[169] It should be noted that while improvements can always be made, oil sands operations have made many advancements in their water management practices; at least according to producers. The Canadian Association of Petroleum Producers notes that oil sands projects recycle up to 95% of the water they use. Additionally, 51% of the water used by in-situ recovery was saline water. These efficiencies mean that by 2020 oil sands development will require less than 0.5% of Alberta's current requirements. Source: CAPP, "Water Use in Canada's Oil Sands," 1.

[170] There are indications that the Federal Government is already taking steps in this direction. The 2011 budget included changes to tax deductions available to the energy industry that slowly phase out a number of these tax subsidies. This implicitly raises the costs of production, meaning that efficiencies need to be found elsewhere, such as by reducing water use. However, this move/policy proposal is largely symbolic in that it likely will have only negligible impacts on water consumption. All it really does is add money to government coffers and shield the governments from claims that it is financially supporting an already-profitable industry that has numerous detrimental environmental impacts. For more information on these changes, see: Government of Canada, "Budget

reduce investment, it would force companies to adopt more economical practices. Moreover, if bitumen processing declined, or grew at a slower rate, it would reduce GHG emissions and reduce water consumption while protecting taxpayer funds. Thus it would serve Canadian interests by promoting environmental, economic and water scarcity without limiting energy output.

Shale Gas

Since the mid-2000s, shale gas has been recognized as a 'game-changing' energy source in North America. Hydraulic fracturing has revolutionized the energy market, which has encouraged the United States to invest heavily into the extraction of unconventional natural gas. Similarly, Canada and Mexico have also begun to implement policy to extract this new energy source. By examining shale gas in the context of climate change, natural gas' ability to emit half as much carbon as coal makes it an attractive and sustainable resource for the future. However, the hydraulic fracturing process associated with shale gas is accompanied by several negative impacts on water resources. For the purpose of our discussion, this portion of the report aims to guide Canadian policy makers in mitigating the negative impacts on water resources associated with the shale gas extraction. In analyzing the potential growth of hydraulic fracturing, shale gas production is expected to substantially increase in North America. The United States' shale gas production has soared in recent decades and currently accounts for 78% of global unconventional gas production.[171] The U.S. possesses 750 trillion cubic feet of recoverable shale resources, 86% percent of which is located in the Northeastern Marcellus shale play.[172] According to the Annual Energy Outlook 2013, shale gas production is projected to grow from 7.8 trillion cubic feet (Tcf) to 16.7 trillion cubic feet by 2040.[173] In comparison to the U.S., Canada possesses a modest amount of recoverable shale gas with 98 trillion cubic feet, 92% of which lies in the Montney and Hom River Basins in Northeast British Columbia.[174] In terms of production, the Canadian National Energy Board estimates a 9% increase in production from 0.47 Bcfd in 2011 to 4.03 Bcfd by 2035.[175] Finally, Mexico has an estimated 681 (Tcf) of recoverable shale gas reserves.[176] Two-thirds of Mexico's recoverable shale gas is located in the northeast and east-central regions of the country known as the Burgos Basin. As of 2011 only one shale gas site has begun operating where it is currently extracting 2.9

2011," June 6, 2011, http://www.budget.gc.ca/2011/plan/chap4a-eng.html, Chapter 4.1, Eliminating Fossil Fuel Subsidies.

[171] IEA (International Energy Agency), *World Energy Outlook 2012*, (Paris: OECD/IEA, 2012), 141.

[172] U.S. Energy Information Administration (EIA), Review of Emerging Resources: U.S. Shale Gas and Shale Plays, Analysis & Projections: release date July 8, 2011, accessed March 15th 2013, http://www.eia.gov/analysis/studies/usshalegas/

[173] U.S. Energy Information Administration (EIA), What is shale gas and why is it important, Energy in Brief: release date December 5, 2012, accessed March 16th 2013, http://www.eia.gov/energy_in_brief/article/about_shale_gas.cfm

[174] National Energy Board, Understanding Canadian Shale Gas, Energy Brief 2009, 1-3.

[175] Ibid.

[176] U.S. Energy Information Administration, *EIA Assessment of World Shale Gas Resources: Mexico*, released October 17th, 2012, accessed March 12th, 2013, http://www.eia.gov/countries/cab.cfm?fips=MX

million cubic feet per day. According to Mexico's state operated oil company PEMEX, further petrochemical development plans are underway to extract shale gas resources by 2027.[177] The hydraulic fracturing process associated with the extraction of shale gas requires large volumes of water over an extended period of time. An operation's total water requirements are generally between 2-4 million gallons per well, depending on the drilling procedure (i.e. horizontal or vertical).[178] According to the Cambridge Energy Research Association, North American water availability is does not appear to be a major obstacle. If 10,000 shale wells are drilled each year and a maximum of 4 million gallons of water are used per well, this would only account for 40 billion gallons of water per year amounting to 0.03 percent of total water use in the United States in 2005—150 trillion gallons.[179] Although this is only a small fraction of annual water use, this water is typically withdrawn over a short period of time in one location, which can pose serious challenges for local water availability.[180] In comparison to ethanol and coal production, shale gas is considerably less water intensive as each of these respective energies requires ten times more water to yield the same amount of energy. In the context of climate change, an increase in the hydraulic fracturing process will have several negative implications on water resources. Since drilling has immediate water requirements, water is most commonly delivered by tanker trucks, which contributes to greenhouse gas emissions (GHG). Additionally, high pressure water usage has the potential to contaminate drinking water aquifers due to the mix of chemical additives. Chemicals are often added to make a high viscous, low friction fluid to help carry materials to the surface.[181] The greatest concern stems from methane contamination encroaching on shallow drinking-water systems. In a recent study, Osborn et al accounts for high levels of methane in three separate regions of the Marcellus shale gas play.[182] This will make water uses in this region unfit for human consumption or agricultural production. Finally, the fracturing process produces large amounts of wastewater, which makes reusing water and disposal procedures particularly difficult.

If Canada intends on expanding production of shale gas, there are several policies that should be implemented to ensure this practice is sustainable for the future and water resources are to be protected. First, with regard to climate change, the extraction of large amounts water and delivery to shale plays via tanker trucks should be eliminated. A more sustainable practice would be the development of an intricate water network that delivers water to a centralized location. This will effectively reduce the greenhouse gas emissions associated with transportation, while

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[177] PEMEX, "PEMEX gets its first shale gas production," released March 23, 2011, http://www.pemex.com/index.cfm?action=news&sectionid=8&catid=40&contentid=24075

[178] Peter H Gleick, *A twenty-first century US water policy*, New York: Oxford University Press (2012), 228.

[179] IHS CERA Special Report, *Fueling North America's Energy Future: The Unconventional Natural Gas Revolution and the Carbon Agenda* (Cambridge: IHS Cambridge Energy Research Associates 2010), 40.

[180] Gleick, 228.

[181] Canadian Society for Unconventional Gas (CSUG), Understanding Hydraulic Fracturing, Calgary: CSUG (2010), 19.

[182] Osborn et al., "Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing", Institute of Ecosystem Studies (2011), 8172.

also protecting local water supplies from being diminished. Second, the Canadian federal government should establish a system to stringently monitor chemicals and impacts of hydraulic fracturing. Currently, the number of chemicals and concentrations added to fluid proppants are not uniform.[183] Individual companies have their own proprietary combination of chemicals, which makes monitoring particularly difficult. Chemical uses should be monitored at both the federal and provincial level to mitigate any potential wastewater impacts. Finally, the federal government should invest heavily into wastewater management technology. Since shale gas fracturing is only expected to increase in the future, developing methods to reuse wastewater or dispose of it safely would promote energy efficiency and water conservation.

Bio-Fuels (Ethanol)

Bio-fuels are commonly referred to as one of the key renewable technologies to reduce CO2 emissions.[184] Additionally, bio-fuels are recognized as a means to aiding national security by providing an additional domestic energy source.[185] Through mandates and subsidies, the United States and Canada have implemented policies to drastically increase the production of bio-fuels.[186] However, in examining bio-energy in the context of climate change, there are several negative environmental impacts on water resources directly associated with this 'sustainable practice'. For the purpose of this discussion, we seek to focus our attention explicitly on increased ethanol production in North America. In doing so, we aim to guide Canadian policy makers in mitigating the negative impacts associated with bio-fuel production. According the International Energy Agency's Medium Term Oil Report: 2012, North American ethanol production will continue to dominate global supply. In the short term, the IEA accounts for over 55% of global ethanol production to come from the North America, primarily the United States, by 2017.[187] Pursuant of the US Renewable Fuel Standard (RFS2), the OECD Agricultural Outlook 2012 accounts for a steady increase of 16 Bnl ethanol to a total of 96 Bnl by 2021.[188] This increase is expected to account for 15% of blended gasoline type fuel.[189] The Government of Canada's ecoENERGY for Bio-fuels Program seeks to expand production over the 2008-2017 period, which would increase production by 0.9 Bnl reaching a total of 2.7 Bnl by

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[183] A proppant is a material that will keep an induced hydraulic fracture open, during or following a fracturing treatment, while the fracking fluid itself varies in composition depending on the type of fracturing used, and can be gel, foam or slickwater-based. In addition, there may be unconventional fracking fluids. Fluids make tradeoffs in such material properties as viscosity, where more viscous fluids can carry more concentrated proppant.
[184] IEA (International Energy Agency), *Technology Roadmap: Biofuel Transportation, Paris*: OECD/IEA (2011), 7-8.
[185] NRC(National Research Council), *Water Implications of Biofuels Production in the United States* (Washington D.C: The National Academies Press 2008), 10.
[186] Peter H Gleick, *A twenty-first century US water policy* (New York: Oxford University Press 2012), 222.
[187] IEA (International Energy Agency), *Oil Medium-Term Market Report 2012: Market Trends and Projections to 2017*, Paris: OECD/IEA (2012), 92.
[188] OECD (Organization of Economic Development), *OECD- FAO Agricultural Outlook 2012-2021*, Paris: OECD/IEA (2012), 94.
[189] Ibid, 94

2021.[190] Overall, this increase is expected to account for a total blend of 5% in gasoline type fuels.[191] Mexico, by contrast, has not yet introduced commercial crop use for bio-fuel production and there appears to be no political support for this transition in the near future. This is due largely to the fact that ethanol is still more expensive than its petroleum based equivalents.[192]

Ethanol production, made up 70% by corn, is a highly water intensive process that is dependent on several factors.[193] Such variables include, crop type, local climate, and irrigation management practices. However, on average, water withdrawals associated with ethanol production ranges from 7 to 110 gallons of water per mill traveled for corn grain and 6 to 63 per mile for celluloses corn stover.[194] The factors which make the production of ethanol particularly water intensive stems from soil evaporation and transpiration from plants, runoff to rivers and streams, and infiltration to the surface aquifer.[195] In addition, bio-refineries use water in the conversion process to break down starch polymers at a very high rate. [196]

The negative implications associated with increased ethanol production are expected to intensify as climate change continues to threaten fresh water availability. Shifting crops to bio-fuel production has the potential to change irrigation water use and local water availability.[197] In North America, the greatest stresses are projected to be in the Western United States' extending from West Texas up in to South Dakota and Wyoming. At the present time, water availability in this region is at its lowest levels in approximately 40 years.[198] The recent 2012 drought in the South Western United States is a strong indication of the intensifying stresses on freshwater resources as a result of climate change for the future. In particular, warming in the North American Western mountain region is expected to lead to decreased snowpack, enhanced winter flooding and reduced summer flows.[199] There are also water quality concerns due to excessive uses of fertilizers and pesticides as enhancement in corn cultivation for ethanol production is expected to lead to increased nitrate concentrations.[200] Though the majority of ethanol production is carried out in the central United States, potential water shortages as a result of climate change challenge the sustainability of bio-fuel production in the long-term because water will be needed for more basic and urgent uses in all North American regions. Finally, and perhaps most importantly, bio-fuel production raises ethical

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[190] Ibid, 95.
[191] Ibid, 95
[192] Luis Chavez, *Uncertainty on the future of Mexican Biofuels*, Mexico: USDA Foreign Agricultural Service (2012), page 2.
[193] Peter H Gleick, A twenty-first century US water policy, 222- 225.
[194] Ibid., 231.
[195] NRC(National Research Council), *Water Implications of Biofuels Production in the United States*, Washington D.C: The National Academies Press (2008), 23.
[196] Ibid., 23-24.
[197] Ibid.,20-21.
[198] NRC, *Water Implications of Biofuels Production in the United States*, 19.
[199] Ibid., 26.
[200] Twomey et al, "The unintended Energy Impact of Increase Nitrate Contamination from Biofuels production," *Journal of Environmental Monitoring,* 12(1), (2010), 218.

concerns. As climate change is expected to stress food production globally, the diversion of land use from crops for food production to first generation bio-fuels will detract from efficient water use and ultimately reduce the global food supply. Diverting corn production to bio-fuels will have implications for both humans and livestock. According to Jay O'Neil of Kansas State University, due to the fact that the United States produces 60-70% of world corn exports, increased ethanol production will reduce the amount of available corn in the world market. This will ultimately cause a spike in prices globally as demand continues to rise, but supply is instead being directed toward fuel production.[201]

If Canada intends on fulfilling its ecoENERGY bio-fuel mandate by 2017, there are several policies that should be implemented to ensure ethanol production is sustainable for the future and water resources are protected.[202] First, in light of climate change and the expected depletion of freshwater resources, the Federal government currently lacks sufficient data on water withdrawals and consumption for bio-fuel production.[203] Consumptive use of water is difficult to quantify due to evaporation losses; however, water withdrawals from groundwater or surface water for industrial use is capable of being monitored. Establishing a network which regulates water use will provide greater insight into the bio-fuel production process. Depending on the future severity of climate change, this network will provide the government with necessary foundation to evaluate the sustainability of bio-fuel production in light of available water resources. Second, the Canadian government should invest in the research and development of technologies to promote alternative water sources. One such method would include investing in technology aimed at the re-use of recycled water from bio-refineries. This would ultimately increase energy efficiency and promote water conservation. Finally, and most importantly, the Canadian federal government should eliminate funding for first generation bio-fuels. First generation bio-fuels are made from conventional food sources, while second generation use 'non-food' crops, such as organic waste and wheat stalks.[204] Using the waste associated with agricultural production would ensure that land is used for food and bio-fuel production simultaneously. This would eliminate any concerns for land availability and global food production, while also reducing the high greenhouse gas emissions associated with energy production.

Hydro-Electricity

When comparing various types of electricity generation in light of the greenhouse gases (GHGs) they produce and the challenges posed by climate change, the advantages of hydropower often come to mind. The majority of hydropower's

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[201] David J. Tenenbaum, "Food vs. Fuel: Diversion of Crops Could Cause More Hunger," *Environmental Health Perspectives* (2008); 116 (6): 254-257.
[202] National Resource Canada (NRC), "EcoENERGY for Biofuels Program," Next-generation Biofuels Fund, accessed March 13th, http://oee.nrcan.gc.ca/transportation/alternative-fuels/programs/8251.
[203] Peter H Gleick, A twenty-first century US water policy, 236.
[204] Matte Jensen and Anne Holst Andersen, "Biofuels: a contested response to climate change", Denmark: Sustainability: Science, Practice, & Policy (2013), p.43.

lifecycle GHGs come from the construction of dams and other related equipment, meaning that the actual production of electricity is not particularly carbon-intensive. However, its generation capacity is greatly constrained by the overall state of water resources and, thus, hydropower facilities can only be built where large and consistent flows exist. This is a major shortfall that limits its use around the globe, and a challenge likely to be exacerbated by climate change impacts on water scarcity. Changes to seasonal and overall water availability in parts of North America could have severe consequences for hydropower's reliability as a major source of electricity.

According to the International Energy Agency (IEA), Canada and the United States are the third and fourth largest producers of hydroelectric power, generating 376 and 328 terawatt hours (TWh) respectively.[205] As a proportion of the total national electricity supply, this means that hydropower currently accounts for 62% of total Canadian capacity, and 7.6% of the American market.[206] However, according to most projections, hydropower's share of the North American electricity market is unlikely to increase. While the IEA estimates that only 39% of the continent's hydroelectric potential has been exploited, the investment costs, as well as the land and water requirements will limit future development.[207] Indeed, the United States Geological Survey envisions that additions to American hydroelectric capacity will come primarily in the form of small-scale plants intended to service a single community.[208] Moreover, similar constraints are expected to restrict the construction of new hydropower facilities in Canada as well. One exception to this projected trend is the proposed 'Site-C Dam' that would be built on the Peace River in Northeast British Columbia.[209] However, because this project is still under consideration and would not (if approved) be operational for several years, it will receive only limited attention. Consequently, the discussion of climate change impacts on hydropower production will largely focus on existing facilities in areas likely to be affected by changes in water availability.

Compared to other types of electricity generation, hydropower stations consume less water than most thermoelectric producers (i.e. nuclear, coal-fired and natural gas-fired plants). However, because they require large volumes of water to spin the turbines, their generating capacity is highly dependent on available surface water resources. Moreover, unlike thermoelectric plants that can adapt to water scarcity by employing closed-loop or dry-loop cooling systems that require substantially less water, hydropower facilities cannot generate electricity without a consistent flow of water. Thus, although they are relatively small consumers of water in that most withdrawals are returned to the original source with few quality impacts, hydroelectric generating stations have little capacity to adapt to short- and

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[205] International Energy Agency, *Technology Roadmap Hydropower* (2012): 10, http://www.iea.org/publications/freepublications/publication/name,32864,en.html (accessed March 16, 2013).
[206] Ibid.
[207] Ibid., 18.
[208] United States Geological Survey, "Hydroelectric Power Water Use," February 14, 2013, http://ga.water.usgs.gov/edu/wuhy.html.
[209] BC Hydro, "What is Site C," January 28, 2013, http://www.bchydro.com/energy_in_bc/projects/site_c/site_c_an_option/what_is_site_c.html.

long-term water shortages. Considering that climate change is expected to reduce water availability in some regions, it is important to determine the possible implications for hydroelectric power generation.

One region that is particularly vulnerable to these effects is the Western United States, because a substantial proportion of American hydroelectric generating capacity is found here. The Southwest, in particular, is projected to experience increased water scarcity that will put its hydroelectric capacity at risk. A study completed by Seager et al. that analyzed a variety of climate models, projects that average annual runoff will decrease by about 10% over the 2021-2040 period in the Colorado River Headwaters, California/Nevada and Texas regions.[210] This has the potential to impact operations at the Hoover Dam, located on the border of Nevada and Arizona, that currently produces nearly 4.2 billion kilowatt-hours (kWh) of electricity per year.[211] The quantity of water available is inherently connected to hydroelectric generating capacity, and a one percent reduction in the quantity of water translates into a one percent or more reduction in output.[212] In this sense, if Seager et al.'s projections prove correct, hydropower capacity in the Southwest will likely see significant losses.[213]

Parts of the Northwest will face similar circumstances, as Washington and Oregon are expected to see net reductions in surface water availability (precipitation – evaporation) in the spring and summer periods (See Figure 2 below).[214] However, reductions in this region likely will not be as significant as in the Southwest, and the emphasis on timing is significant. As electricity demand varies throughout the year, generally peaking in the summer, the timing of water shortages will have direct implications for hydroelectric production. If increasing water scarcity leads to decreasing electrical output in high demand periods, supply will have to be increased by other forms of electricity, possibly including fossil fuel-based energies which will further exacerbate climate change. However, it should be noted that while water shortages in the spring and summer are likely and will decrease generating capacity for producers in the Northwest region, increased precipitation is projected for the autumn and winter months (See Figure 2 below). The Columbia River system provides water for a number of large scale power plants in Washington, Oregon, as well as across the U.S.-Canada border in British Columbia. As such, changes to its

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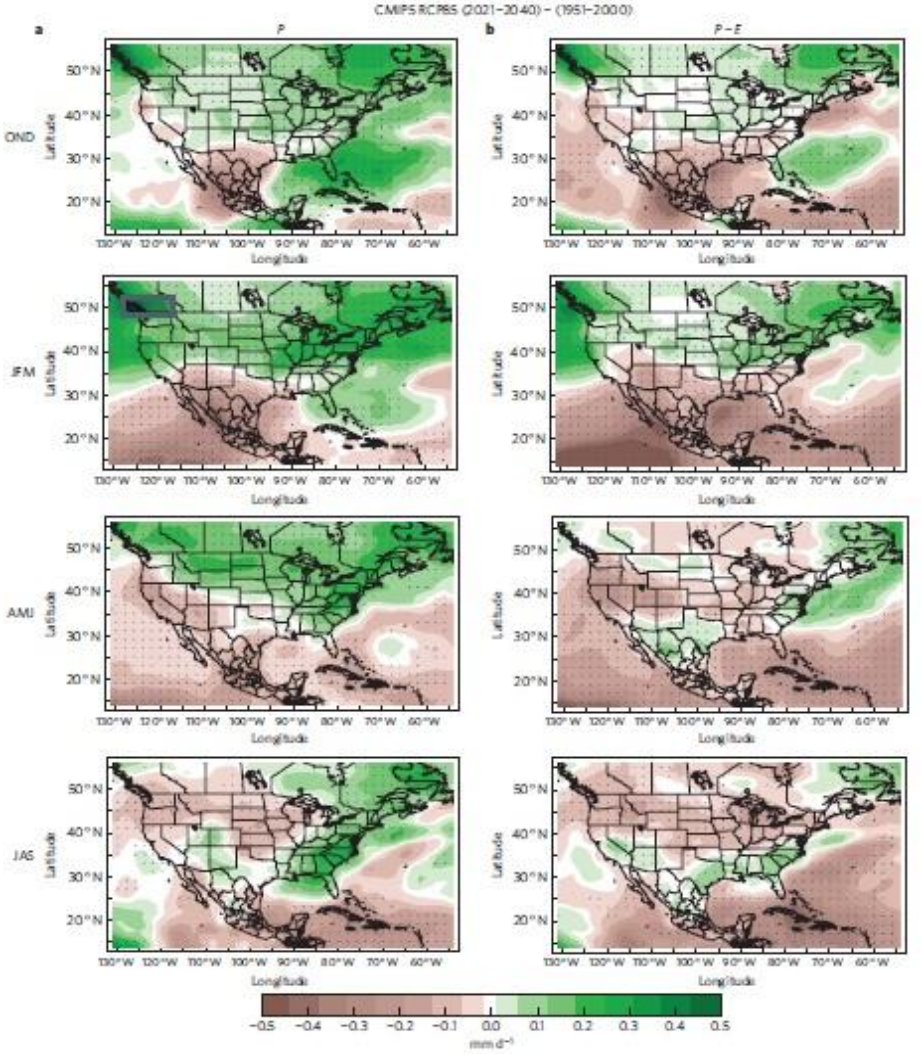
[210] Richard Seager et al., "Projections of Declining Surface-Water Availability for the Southwestern United States," *Nature Climate Change* (Dec. 2012), 4.
[211] United States Department of the Interior: Bureau of Reclamation, "Hydropower at Hoover Dam," February 2009, http://www.usbr.gov/lc/hooverdam/faqs/powerfaq.html.
[212] US Climate Change Science Program, *Effects of Climate Change on Energy Production and Use in the United States*, February 2008: 41, http://www.climatescience.gov/Library/sap/sap4-5/final-report/sap4-5-final-all.pdf (accessed November 23, 2012).
[213] See also: United States Global Change Research Program, *National Climate Assessment, (Draft Report), 2013*, Chapter 4: Energy Supply and Use, http://www.globalchange.gov/what-we-do/assessment. According to these projections, the Southwest will face an additional ten days with less than 0.1 inches of precipitation by 2055, which is expected to reduce hydroelectric generating capacity (See chart on p.181 of the Draft Report).
[214] Seager et al., 2.

flow rates can have significant impacts on each of the aforementioned regions.[215] Increased precipitation at any time of the year, including in the autumn and winter, can reduce the quantity of electricity required from other (possibly more polluting) power utilities. Thus, while the effects of climate change on water availability can have negative consequences for hydroelectric generation, opportunities also exist.

Figure 2: Precipitation (Left) and Precipitation – Evaporation (Right) Projections for the United States 2021-2040: Autumn, Winter, Spring, Summer (Top to Bottom)[216]



The inevitability of climate change and its projected impacts on water scarcity necessitate that all levels of government in Canada act proactively in order to maintain energy security. With regard to hydroelectricity, this requires the federal government, in particular, to devote enhanced resources to research and information

[215] United States Global Change Research Program, 181. The Draft National Climate Assessment projects an additional six days with less than 0.1 inches of precipitation in the U.S. Northwest, which will almost certainly impact hydroelectricity production.
[216] Seager et al., 2.

sharing among the provinces. While provincial governments ultimately have control over power utilities, these decisions should be made based upon the most up-to-date and credible scientific projections concerning climate change impacts on water security. Hydroelectric power plants are an effective way to promote energy security while at the same time minimizing GHG emissions output. However, this requires expensive initial investments that must be justified by power plants' long-term output. For example, proponents of the Site-C Dam currently under consideration for the Peace River in British Columbia expect it to service the province for 'over 100 years'.[217] Therefore, the decision-making process must take into account how climate change will impact the local water supply through its effects on glacial melting, precipitation and evaporation. Approvals of the Site-C Dam and other similar hydroelectric projects across the country must be contingent on adequate water resources not only for the plant itself, but also for the communities and industries downstream. This will ensure that Canadian energy policy is consistent with an interests-based approach that respects the human right to water.

(4) MIGRATION

While the projected impacts of climate change on energy are important to note, climate change will also impact North American migration, specifically from Mexico and Latin America. Mexican and Latin American migration to the U.S. is already quite substantial, as it is estimated that 6.1 million illegal migrants are currently residing in the U.S.[218] In fact, it is estimated that over 250,000 migrants illegally migrate every year from Mexico to the U.S.[219] A human security approach to climate change induced migration is of particular relevance for the U.S-Mexico immigration relationship. The security of entire populations on both sides of the international border is at stake. A brief overview of the history of Mexican migration to the U.S, going back to the Mexican-American war, reveals that this migration is not a new phenomenon. The period from 1970 to 2005, however, saw a rise from 1.5% to 10.2% in the share of people of Mexican origin living in the U.S.[220] Indeed, the number of illegal migrants[221] that travel to the U.S. has caused substantial fear. This fear has prompted military analyst Gwynne Dyer to provide a worst case scenario in his book

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[217] BC Hydro.
[218] Ross D Franklin, "Number of Illegal Immigrants from Mexico Drops for the First Time in Decades: Report," The Associated Press, April 23 2012.
[219]Jennifer M. Chacon. "Misery and Myopia: Understanding the Failures of the U.S. Efforts to Stop Human Trafficking." *Fordham Law Review* (May 2006): 2990. The most recent statistics from 2012 note Mexico as having a population of approximately 115,639,915 in 2012; 77.8% of the population is concentrated in urban areas. Of this population 86,081,615 people are over the age of 14, of which 50,693,306 are considered to be economically active and 35,388,309 not economically active. The population is relatively young with an overall average age of 26 and a life expectancy of 75 years; this population is expected to double by 2050. "Población, Hogares y Vivienda." Last Modified January 16 2013.
http://www.inegi.org.mx/Sistemas/temasV2/Default.aspx?s=est&c=17484
http://www.encuentra.gob.mx/resultsAPF.html?q=2030%20Water%20Agenda&client=cna-conagua
[220] Ibid.
[221] Within the U.S, Census, Mexicans and Latin Americans are combined under one category.

"Climate Wars." Dyer's scenario is set in 2029, in which the U.S. has built two border barriers; these include two parallel three metre open-mesh fences with razor wire on top. [222] Such measures were implemented to address the problem of illegal immigration. While this is extreme, Dyer demonstrates the concern in the U.S. regarding the weakness of the U.S.-Mexico border. This results in increased support for stronger border controls and better relationships between intelligence agencies and states. While there have been several measures to better secure the U.S.-Mexico border, such as the "Secure Fence Act of 2006," illegal immigrants are still able to enter the United States. As such, the following section will analyze how the consequences of climate change may lead to further Mexican and Latin American migration to the U.S., and what this may mean for U.S. security.

Climate change is likely to impact water security in the northern and central Mexican states, as well as the southern U.S. states.[223] Some 56% of Mexico's land mass consists of arid and semi-arid ecosystems with limited rainfall; meanwhile 72% of that rainfall evaporates back into the atmosphere.[224] According to the Germanwatch Global Climate Risk Index from 1991-2010, Mexico was ranked forty-ninth in countries facing a severe climate risk.[225] Indeed, climate change is likely to impact rainfall patterns in Mexico, which will lead to intensive rains in southern Mexico, and droughts in the northern and central states. In the north and northwest, a 10-15% decrease in rainfall is expected,[226] with this region already receiving only 25% of the nation's rainfall.[227] The Mexican states that will be most affected by water insecurity, according to Mexico's National Meteorological Service (SMN), are Baja California, Chihuahua, Coahuila, and Durango. These assumptions are based on factors such as high temperatures, low rainfall, as well as high level of water and energy consumption (see Figure 1 and 2).[228] The effects of fluctuations associated with El Niño Southern Oscillation (ENSO) may also lead to much more severe droughts, resulting in serious deficits in reservoir levels, shortages of rain-fed agriculture, reduction in water quality, and the worsening of water pollution.[229] There is, however, a great deal of uncertainty surrounding ENSO as it remains a highly complex phenomenon yet to be fully understood by scientists and researchers.

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[222] Gwynne Dyer, *Climate Wars* (Toronto: Random House Canada, 2008), 78.
[223] UK Met Office, Department of Energy, *Climate: Observations, Projections and Impacts* (Devon, United Kingdom: The Met Office, 2011), 2. http://www.metoffice.gov.uk/media/pdf/c/6/Mexico.pdf. Global studies have concluded Mexico is highly vulnerable to water security.
[224] The Royal United Service Institute for Defence and Security Studies, *Climate Change, Migration, and* Security, *Best-Practice Policy and Operational Options for Mexico*, by Elizabeth Deheza and Jorge Mora (Whitehall, London, 2013), 25. http://www.rusi.org/downloads/assets/WHR_1-13_web.pdf.
[225] Ibid.
[226] Ibid, 55.
[227] Ibid.
[228] Ibid, 26. Other Mexican states that will be affected are Nuevo Leon, Zacatecas, San Luis, Potosi, Aguascalientes, Guanajuato, Baja California, Sonora, Sinaloa, Queretaro, Hidalgo, and Tlaxcala.
[229] Ibid.

Figure 1: Total Changes in Precipitation in Mexico

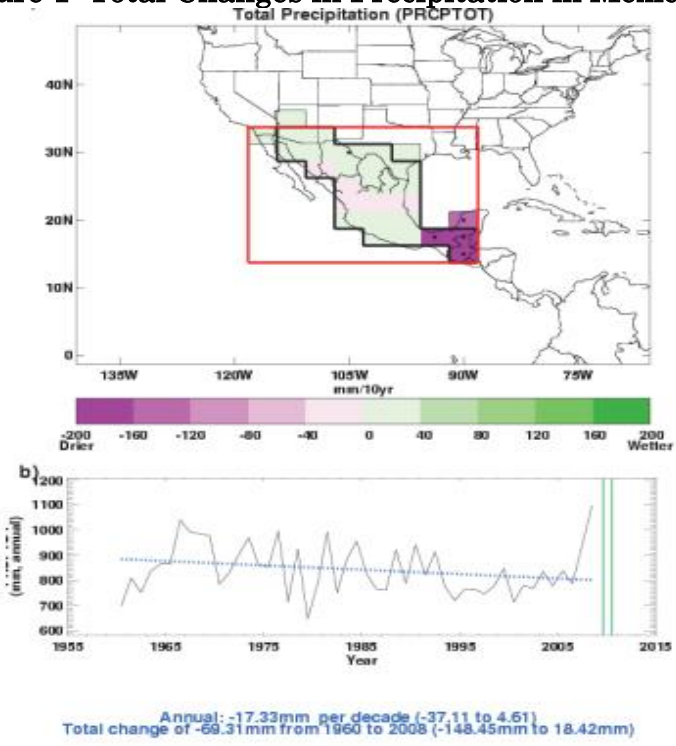

Figure 2: State Map of Mexico

Causal linkages between climate change and migration are complex and difficult to identify; however, the aforementioned consequences of climate change will likely lead to migration. The decision to migrate is complex, with many variables to be considered. People may adapt to these environmental consequences through temporary or permanent migration,[230] similar to how migration is used as an adaptation strategy for other pressures on household livelihoods.[231] The decision to migrate is based upon the interaction of 'push' and 'pull' factors. 'Push' factors are those factors that contribute to a migrants' decision to leave, while 'pull' factors are characteristics of the destination country that encourage migration to that country. Studies have examined numerous factors underlying Mexican emigration, including negative labour demand shocks, labour supply shocks resulting from demographic changes, US immigration policy changes, migrant networks, and importation of cheap corn and other agricultural products following the North American Free Trade Agreement.[232] These factors are not extensive, however, because factors such as population, population density, poor irrigation, water insecurity and water pollution are other "pull" factors. The applicability of these factors within the context of Mexican migration will now be discussed.

Mexico presents an imbalance between the supply and demand for water. Currently, 78.4 billion cubic meters are required every year and to supply this quantity and 11.5 billion cubic meters are taken from non-sustainable sources. If this continues, the current gap will be doubled within a 20 year period.[233] The main challenges are faced in the Lerma and Grande river basins, where there are cells in which the gap foreseen will not be bridged without resorting to inter-basin transfers or by reducing the withdrawal of water for irrigation.[234] Ensuring this demand is sustainably met will require investments of approximately USD 25.44 billion up until to 2030.[235] Currently, 91.3% of the population has access to drinking water services and 89.9% has sanitation coverage.[236] It is worth noting that the drinking water available is plagued with widespread contamination and that in 2010, though 89.9% of all wastewater generated was collected in sewer systems, only 43.4% of wastewater received treatment.[237] Considering the current coverage and the population growth, the challenge will be to extend access to drinking water and sanitation services to a further 36.8 to 40.5 million inhabitants.[238] Thus, these difficulties are likely to

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[230]The degree to which climate change will encourage migration is not well understood, as there are a variety of variables that are necessary to consider.

[231] Alex de Sherbinin et al, "Migration and Risk: Net Migration in Marginal Ecosystems and Hazardous Areas," in *Environmental Research Letters* 7 (2012): 2. The Millennium Economic Assessment stated that, with medium certainty, droughts and land degradation were the key factors behind migration from dry-land areas.

[232] Shuaizhang Feng, Alan B. Krueger, Michael Oppenheimer and Stephen H. Schneider, "Linkages among climate change, crop yields and Mexico–US cross-border migration," *Proceedings of the National Academy of Science*, Vol. 107, No. 32 (August 10, 2010), 14257-14262.

[233] "2030 Water Agenda."Last modified March 2011.

[234] Ibid.

[235] Ibid.

[236] Ibid.

[237] Ibid.

[238] Ibid.

contribute to migration from these regions. Climate-induced migrants from Mexico are expected to migrate either within Mexico, or illegally migrate to the United States. In regards to access to drinking water and sanitation services, the states that will face the greatest challenges due to water insecurity are Baja California, Chiapas, State of Mexico, Jalisco, Puebla and Veracruz.[239] (See Figure 2).

Mexico is the single largest source of undocumented immigrants to the United States. Five municipalities with the highest rate of outward migration – Leon (Guanajuato), Puebla (Puebla), Juarez (Chihuahua), Zapopan (Jalisco) and Morelia (Michoacán) – together account for 6 per cent of Mexico's international migrants.[240] It is worth noting that the most water insecure states in Mexico - from low rainfall, high water and energy consumption, and drinking water, and sanitation challenges - have the highest rates of outward migration.[241] Those who choose to migrate to the U.S. come primarily from the northern Mexican states, as well as from El Salvador, Guatemala and Honduras (See Table 2). Migrants frequently travel to certain states in Mexico, such as

[239] Ibid.

[240] The Royal United Service Institute for Defence and Security Studies, *Climate Change, Migration, and Security, Best-Practice Policy and Operational Options for Mexico*, 14. Migrants also move to Mexico from other parts of Latin America, such as Guatemala, El Salvador, Honduras and Nicaragua

[241] The Royal United Service Institute for Defence and Security Studies, *Climate Change, Migration, and* Security, *Best-Practice Policy and Operational Options for Mexico*, 27. Guanajuato has been identified as a city that will be subject to severe water insecurity, potentially increasing the migrants that will come from the state of Guanajuato.

Table 2: Estimated totals of Foreign Born Population from Latin America and the Caribbean.

Table 2.

Foreign-Born Population From Latin America and the Caribbean by Country of Birth: 2010

(Numbers in thousands. Data based on sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *www.census.gov/acs/www*)

Region and country of birth	Number		Percent of total		Percent of region	
	Estimate	Margin of error (±)[1]	Estimate	Margin of error (±)[1]	Estimate	Margin of error (±)[1]
Total	**21,224**	**90**	**100.0**	**(X)**	**(X)**	**(X)**
Caribbean	3,731	42	17.6	0.2	100.0	(X)
Cuba	1,105	27	5.2	0.1	29.6	0.6
Dominican Republic	879	24	4.1	0.1	23.6	0.6
Haiti	587	21	2.8	0.1	15.7	0.6
Jamaica	660	20	3.1	0.1	17.7	0.5
Other Caribbean [2]	500	17	2.4	0.1	13.4	0.4
Central America	14,764	90	69.6	0.2	100.0	(X)
Mexico	11,711	83	55.2	0.3	79.3	0.3
El Salvador	1,214	34	5.7	0.2	8.2	0.2
Guatemala	831	29	3.9	0.1	5.6	0.2
Honduras	523	24	2.5	0.1	3.5	0.2
Other Central America [3]	485	17	2.3	0.1	3.3	0.1
South America	2,730	42	12.9	0.2	100.0	(X)
Brazil	340	15	1.6	0.1	12.4	0.5
Colombia	637	19	3.0	0.1	23.3	0.6
Ecuador	443	20	2.1	0.1	16.2	0.6
Peru	429	18	2.0	0.1	15.7	0.6
Other South America [4]	882	23	4.2	0.1	32.3	0.7

(X) Not applicable.

[1] Data are based on a sample and are subject to sampling variability. A margin of error is a measure of an estimate's variability. The larger the margin of error is in relation to the size of the estimate, the less reliable the estimate. This number when added to and subtracted from the estimate forms the 90 percent confidence interval.

[2] Other Caribbean includes Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, British Virgin Islands, Cayman Islands, Dominica, Grenada, the former country of Guadeloupe (including St. Barthélemy and Saint-Martin), Martinique, Montserrat, the former country of the Netherlands Antilles (including Bonaire, Curaçao, Saba, Sint Eustatius, and Sint Maarten), St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, and Turks and Caicos Islands.

[3] Other Central America includes Belize, Costa Rica, Nicaragua, and Panama.

[4] Other South America includes Argentina, Bolivia, Chile, Falkland Islands, French Guiana, Guyana, Paraguay, Suriname, Uruguay, and Venezuela.

Source: U.S. Census Bureau, 2010 American Community Survey.

Baja California, while popular destination cities include Chihuahua, Nuevo Laredo, Reynosa, Nogales, Piedras, Negras, Ciudad Juarez, Matamoros, Mexicali, Mexico City, and Tijuana.[242] These cities are likely to be impacted by water insecurity, and thus these difficulties will be exacerbated by increased migration. As well, areas in Mexico projected to have increased rainfall may also become migration destinations.

When entering the US, they often choose to reside in the southern U.S. states, particularly Texas (see Figure 3). Estimates for the illegal migrants in the future vary depending on the source. Some argue that efforts by U.S. officials to prevent illegal immigration have been successful, as illegal immigration from Mexico has been on the decline recently.[243] Recent reports suggest few are left to migrate from Mexico.[244] Others, such as Gwynne Dyer, believe that climate change will increase the number of illegal migrants, with Dyer citing the possibility of over 1 million a month by 2020.[245]

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[242] The Royal United Service Institute for Defence and Security Studies, Climate Change, Migration, and Security, *Best-Practice Policy and Operational Options for Mexico*, 14.

[243] Ibid. See also Jeffrey Passel et al, *Net Migration from Mexico Falls to Zero – Perhaps Less* (Washington D.C.: Pew Hispanic Center, 2012).

[244] *New York Times*, "New Wave of Mexican Immigrants Seems Unlikely," April 2, 2013.

[245] Dyer, 79-80. While many of these migrants are not climate induced migrants, as Paty Romero Lankao, Deputy Director for the Institute for the Study of Society and Environment at the National Center for Atmospheric

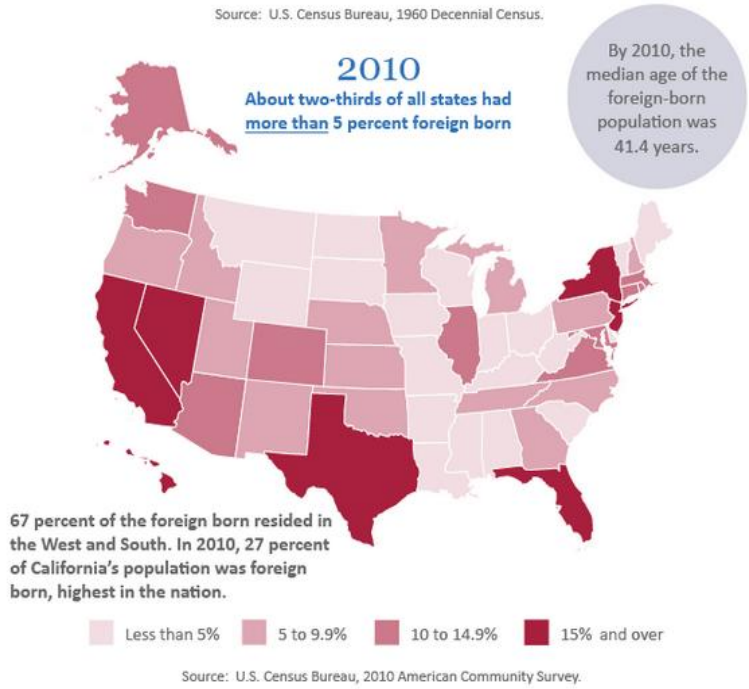

Figure 3: Where both illegal and legal migrants from Mexico are residing.

With the potential for illegal migration from Mexico to increase due to climate change and water security, the U.S. government has identified climate change as a substantial security threat.[246] In 2010, the Pentagon identified climate-induced migration as a major security threat for the U.S. that could result in an increase in regional tensions across the globe.[247] These climate-induced migrants are residing in southern U.S. states, states that will also experience water and food insecurity. A consequence of this could be that the climate-induced migrants will place further strain on the southern U.S. water systems, impacting U.S. water security.

Potential security threats could result in an intensification of U.S. border security. Such intensification would result in severe consequences, specifically in the realm of trade between the two countries.[248] Furthermore, this could have ramifications on the North American Free Trade Agreement (NAFTA) between Canada, the U.S. and Mexico (for the importance of NAFTA for all three economies, see Figure 4). NAFTA encourages each country to import primarily from their

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Research states, "Mexico is already facing a lot of stresses…people are already migrating because of these reasons. Add to that climate change, and you have a bomb." Migrants from Latin America and Mexico often land and reside in southern U.S. states, particularly Texas (see Figure 3).

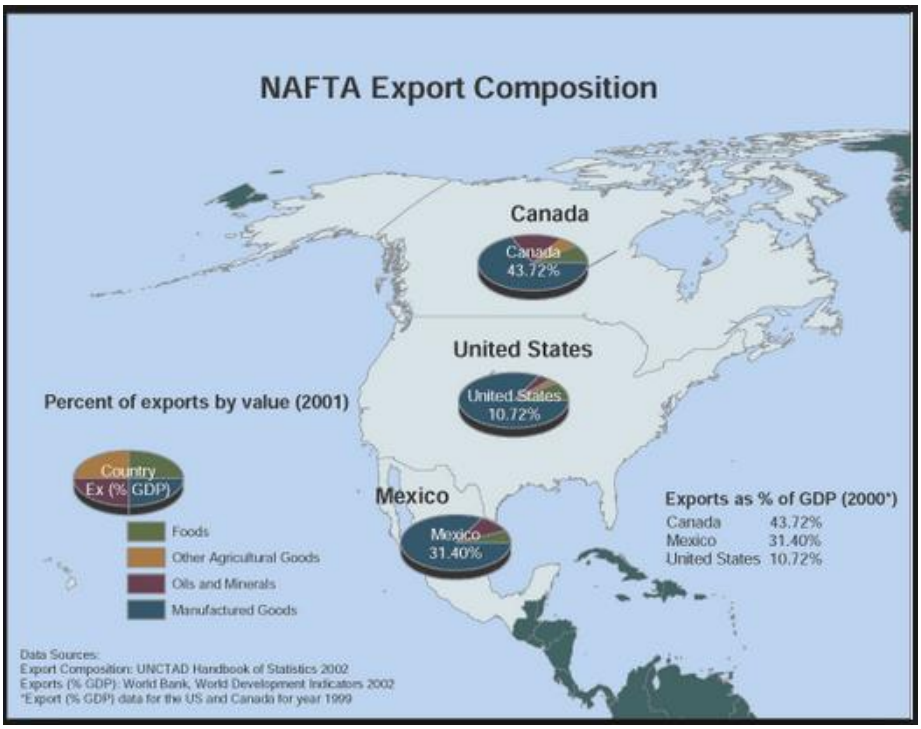
[246] The Royal United Service Institute for Defence and Security Studies, *Climate Change, Migration, and* Security, *Best-Practice Policy and Operational Options for Mexico*, 10.

[247] Ibid.

[248] Eric De La Garza and David R. Mares, *Developing the U.S.-Mexico Border Region for a Prosperous and Secure Relationship*, Baker Institute Policy Report 38: 7-8. Eighty percent of Mexican exports are to the U.S. and fifty percent of Mexico's imports come from the U.S.

economic partners. Both Canada and Mexico rely heavily on U.S. imports, the U.S. reciprocates this relationship by importing heavily from these two countries.[249] Thus, an increase in border security could harm the economies of each country. As such, Romero-Lankao recommended that the U.S. be concerned with illegal immigration, but not impose stringent border policies.[250] As well, by tightening the border, migrants will be forced to reside in Mexico. As many parts of Mexico may experience water insecurity, increased U.S. border policies may result in a competition over key resources in Mexico, encouraging conflict and illegal human trafficking.

Figure 4.[251]



While illegal migration from Mexico may impact U.S. security, it is unlikely that Canada will be affected. Unlike the U.S.-Mexico border, the Canada-U.S. border has been less susceptible to illegal migration. Also, since Canada does not have a position on including environmental migrants as refugees,[252] it is unlikely that it

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[249] Office of the United States Trade Representative, *North American Free Trade Agreement (NAFTA)*, (Washington 2011). http://www.ustr.gov/trade-agreements/free-trade-agreements/north-american-free-trade-agreement-nafta.

[250]Dyer, 80.

[251] UC Atlas of Global Inequality, Regional Trading Blocs, June 2011. http://ucatlas.ucsc.edu/trade/subtheme_trade_blocs.php.

[252] Jessica B. Cooper, "Environmental Refugees: Meeting the Requirements of the Refugee Definition." *NYU Environmental Law Journal*, Vol 6, No. 2 (1997-1998): 480. There is an extensive debate surrounding the inclusion of environmental migrants as refugees. While this paper does not permit a full discussion of this issue, proponents of including environmental migrants as refugees argue that it is in line with human rights, such as the right to life, liberty, and the security of the person. Those against the inclusion argue the United Nations cannot currently support the refugees under its mandate, and the expansion of the refugee definition would result in further difficulties under the refugee regime.

would accept Mexican climate-induced migrants and relieve the pressure placed on the U.S. immigration and border system. As a result, the impact climate-induced migration from Mexico would have on Canada would be through the restraints on NAFTA caused by increased border control.

Canada should encourage the Mexican government to adopt mitigation and adaption techniques to minimize the impacts that climate change and water insecurity will have on Mexican communities, particularly regarding mitigating the consequences of drought. These policies are often drafted following periods of drought, and pre-emptive measures may reduce their impact. Moreover, the Mexican government should begin an education program to inform the populace of these efforts. While migration is an effective adaptive strategy, it is not a viable option for the entire population. The U.S. and Mexico should plan ahead in the event that the projected trends of climate-induced migration become a reality. In addition, the international community, including Canada, should consider development projects as well as resettlement and adaptation programs for those threatened by climate change.[253] The international community should also create and fund an institution that would oversee climate-induced migration.

The Canadian government must adopt an explicit policy regarding environmental refugees, and the degree to which it is willing to commit resources to the efforts mentioned previously. Canada should also alter its current immigration policy. With both the Safe-Third Country Agreement (STCA) and the Protecting Canada's Immigration System Act,[254] Canada has demonstrated a tough stance on immigration in the last eleven years. According to the STCA, a refugee can only apply for asylum in the country they first land in. While both the U.S. and Canada do not recognize environmental migrants as refugees, even if this were changed in the future, a Mexican refugee would be forced to apply for asylum in the U.S.

To alleviate the pressures southern U.S. states will face and to avoid security concerns, Canada and the U.S. should discuss the feasibility of including environmental migrants as refugees, as well as discussing amending the STCA to allow environmental migrants from Mexico to claim asylum in Canada. Furthermore, Canada should actively seek to alleviate the pressures placed on the American immigration system by opening itself to the possibility of absorbing a larger portion of potential Mexican and Latin American migrants otherwise destined for the U.S. This can be achieved by the active recruitment of possible migrants from Mexico and Latin America.[255] Finally, Canada should seek to invest heavily in water management projects in Mexico and the sharing of the relevant knowledge related to sanitation and water purification methods and technologies.

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[253] The Global Governance Project, *Preparing for a Warmer World: Towards a Global Governance System to Protect Climate Refugees* (Working Paper No. 33), by Frank Biermann and Ingrid Boas. (Amsterdam: The Global Governance Project, 2007), 13.

[254] See Canadian Interests section for full outline of these policies.

[255] Harold Troper, "Canada's Immigration Policy since 1945," *International Journal*, Vol. 48, No. 2, (Spring, 1993), pp. 255-281.

LATIN AMERICA

Climate Change, Water Security, and Latin America

This section of the report focuses specifically on the challenges facing Latin America as a result of climate induced water insecurity. Areas of the greatest concern include water governance, availability of accessibility to water resources, the relationship between climate change and agriculture, and water supply and sanitation. Climate induced water insecurity in individual countries has wider implications for the region as a whole, and for the international community.

Regional Climate Science: Latin America

Climate projections for Latin America and the Caribbean (LAC) indicate that the region will suffer severe and potentially debilitating effects from climate change. In terms of temperature, the average regional temperature will continue to rise gradually but persistently, albeit with regional differences, and that there will be changes in patterns of quantity, intensity, and frequency of precipitation.[256] On specific climate scenarios for the Caribbean there is a high level of uncertainty. Climate scenarios suggest that significant variations in average temperature increases and patterns of precipitation could occur. However, it is possible to expect an increase in average temperature between 2.3°C and 3.4°C for the whole region by the end of the century.[257]

The IPCC Fourth Assessment Report presents distinct patterns when explaining predicted changes in precipitation in LAC. Despite the presence of strong scientific data, projected precipitation models cannot predict the expected changes in regional precipitation with any certainty.[258] Further, predicting rainfall is difficult due to the differentiation of wet and dry seasons, which vary by region. The IPCC does predict that rainfall in the LAC will either reduce by 20% or increase by 10% by 2050 depending on regional geography.[259] These uncertain projections suggest, on average, that there will be very little change in precipitation in LAC by 2050. However, the total number of seasonal droughts and floods is projected to increase as a result of intensified El Nino[260] and La Nina. Regional climate change has the potential to intensify both El Nino and La Nina, which could result in increased flooding during El Nino and droughts during La Nina. In terms of total precipitation, increasingly severe El Nino and La Nina events would technically balance each other out, balancing periods of decreased precipitation with periods of increased precipitation. However, both decreased accessibility to water during La Nina, and

[256] Gustavo Carlomano, "Impactos Potenciales del Cambio Climatico en la Seguridad Regional en America Latina," *Friedrich Ebert Stiftung* (2012), 24.
[257] Ibid, 25.
[258] IPCC, *Climate Change 2007: Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, IPCC, Geneva, Switzerland, 2007.
[259] Ibid.
[260] For a definition of El Nino and La Nina, see Appendix.

potential damage to infrastructure and crops during El Nino, could have significant ramifications in Latin America.[261]

Another key concern that has arisen in Latin America with the onset of climate change is glacial melting. The issue has become regionally important given that it has a profound impact on water availability in low-lying mountain valleys. In addition, increased glacial melt water in warmer months stresses water specific infrastructure and contributes to the onset of flooding and other natural disasters. Between 1962 and 2008, Andean glaciers have melted between 20-87%, depending on geographical location, glacial size, and mountain elevation.[262] In the Peruvian Andes, permanent glacial melt has resulted in size reductions ranging from 20-30%.[263] The Venezuelan Andes has experienced an 87% decrease in glacial extent between 1967 and 2008.[264] Overall, future model projects predict that, given the current climate context, Andean glaciers will disappear by the end of the century.[265]

(1) WATER GOVERNANCE IN LATIN AMERICA

The pressures of unabated global climate change have made water governance[266] an increasingly urgent issue given its importance in ensuring water accessibility for human consumption, food and energy production, and overall water quality. Climate change will exacerbate issues of water governance, placing additional pressure on weak physical infrastructure, magnifying problematic water policies, stressing already troublesome inter and intra state relations, and affecting accessibility through increased water theft.

Water Infrastructure In Latin America

A primary concern relating to water governance in Latin America is its relatively weak physical infrastructure. Latin America's water infrastructure struggles to manage surging hydrological flows as a result of sudden demand increases (see **Figure 1**), intensifying annual precipitation (see **Figure 2**), and increased glacial runoff.[267] Various models and projections have estimated that the cost of modernizing regional water infrastructure to meet industrial and municipal water needs is between 0.01 and 0.05 percent of regional gross domestic product (GDP).[268] While the goal of increasing investment by 0.01-0.05 percent of regional

[261] European Commission, "Climate Change and Latin America," 200. Belgium: 2009. 14.
[262] A. Rabatel et al, "Current State of Glaciers in the Tropical Andes: A Multi-Century," *The Cryosphere* 7 (2013): 97.
[263] Ibid, 87.
[264] Ibid, 89.
[265] Ibid, 97.
[266] For the purposes of this section of the report, water governance will be defined as, "the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society." Definition found in Peter Rogers & Alan Hall, "Effective Water Governance," TEC Background Papers No. 7 (Stockholm: Global Water Partnership, 2003): 7.
[267] Philip J. Ward et al, "Partial Costs of Global Climate Change Adaptation for the Supply of Raw Industrial and Municipal Water: A Methodology and Application," *Environmental Research Letters* 5 (2010): 7.
[268] Ibid, 7.

GDP is feasible, disparities in fiscal abilities and existing infrastructure make it difficult for the region's poorer countries, such as Haiti, Nicaragua, Guatemala, and El Salvador, among others, to meet these requirements. Thus, in order for Latin America as a whole to upgrade its physical infrastructure to an appropriate level, larger investments are needed by the region's wealthier nations. However, rational self-interest makes it unlikely that countries will make sizeable contributions to improving infrastructure in other countries if it is not clear how it will benefit them.

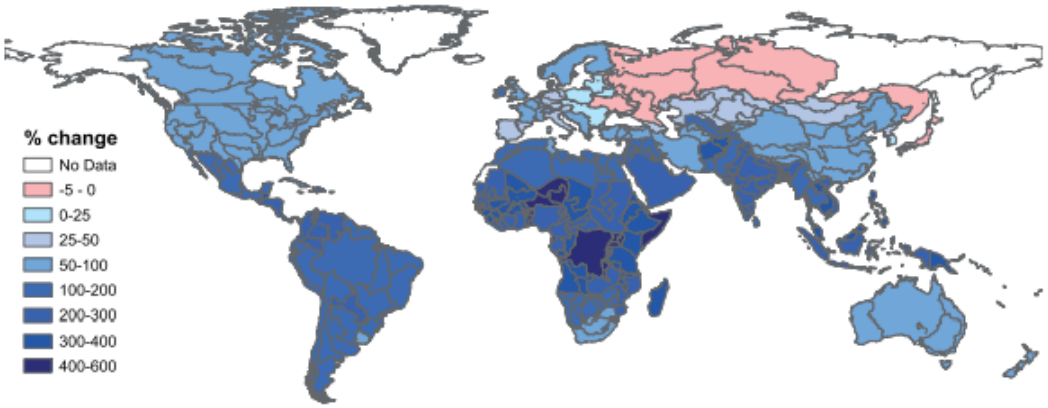

Figure 1: Percentage change in annual industrial and municipal water demands between1961-1990, and to expected demand increases to 2050.[269]

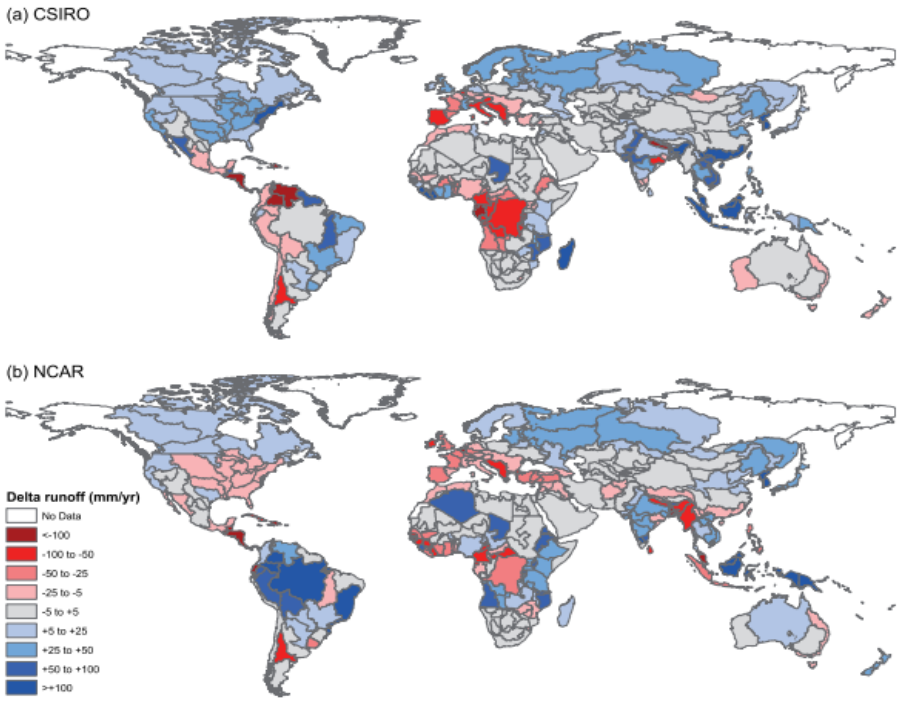

Figure 2: Mean annual runoff (in millimeters) between 1961-1990, and to expected increased to 2050.[270]

[269] Ibid, 6.

A failure to pursue adaptive policies in the near future will have fear-reaching and irreversible consequences for human security and the economic health of the region in coming decades. One reason why Latin American states should upgrade their infrastructure as soon as possible is that model projections estimate that the regional cost of climate change for industrial and municipal water infrastructure far exceeds the potential abatement cost.[271] It is cheaper for countries to address the issue now, before climate related consequences occur. Second, given the context of this report, which emphasizes water as a 'human right,' substandard water governance and inadequate investment will mean a failure to meet the social minimums of the 2006 Human Development Report, which guarantees "access to resources sufficient to meet basic needs and live a dignified life."[272] In addition, populations will be subject to potentially debilitating natural disasters, such as flooding and mudslides that result from violent downpours and melting glaciers.[273] People situated in low-lying mountain valley and coastal regions will be subject to basin overflows should infrastructure not be updated to adequately support increased runoff.

Water Policies & Conflict In Latin America

Climate change may exacerbate weak domestic and regional water policies and potentially lead to conflicts over water. Water conflict in Latin America is not a new phenomenon. In October 2009, the Peruvian Ombudsperson reported 132 socio-environmental conflicts, an increase from April 2007, which witnessed only 32 such conflicts.[274] Water conflicts have arisen from increased competition for access to water resources amongst agricultural, industrial, mining and energy companies, as well as large cities and housing developments in wealthier regions. In order to secure business interests, "the social elite and wealthy corporations take advantage of weak management structure" with the result being that new water policies have disregarded water rights through monopolization of access and control.[275] Research in Peru indicates that many reported water conflicts occur in mountainous regions, such as the Rio Santa watershed in the Andes, where increased glacial runoff has provided an incentive to secure greater access (see **Figure 3**). It is estimated that by 2025, regardless of high or low climate change scenarios, the Coropuna glacier in Peru will not contain enough water to service low-lying valleys and communities.[276] In essence,

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[270] Ibid, 6.
[271] Ibid, 5.
[272] United Nations Development Program, *Human Development Report 2006* (New York: Palgrave Macmillan, 2006): 3.
[273] Jeffrey Stark, "Follow the Water: Emerging Issues of Climate Change and Conflict in Peru." United States Agency for International Development (FESS-USAID) Discussion Paper No. 5 (2012): 25.
[274] Rutgerd Boelens et al, "Threats to Sustainable Future: Water Accumulation and Conflict in Latin America," *Sustainable Development Law & Policy* 21(1) (2011): 44.
[275] Ibid, 41.
[276] Stark, 24.

water scarcity is manufactured through political processes and institutions that advantage wealthy companies, and disadvantage the poor local communities.[277]

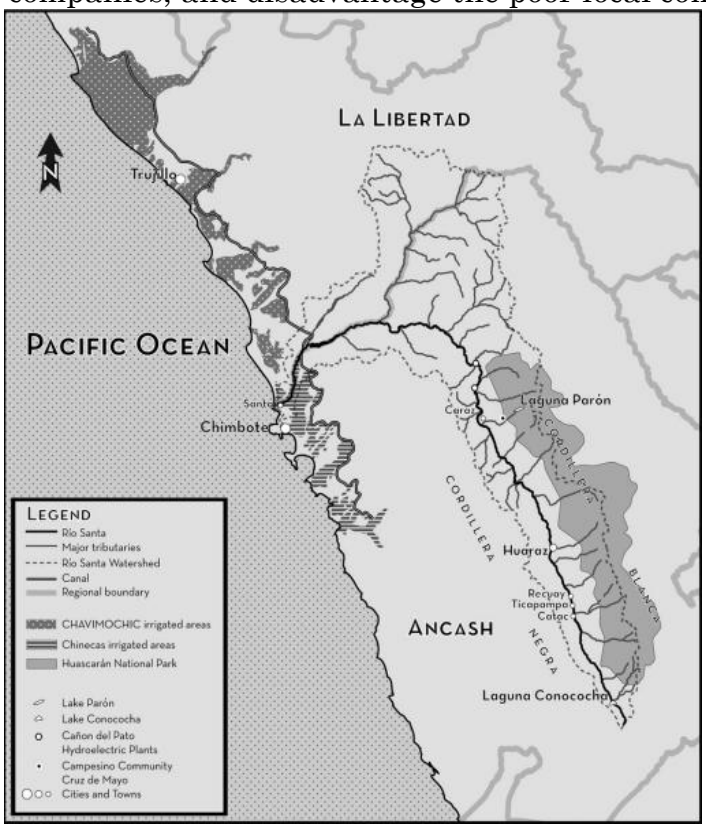

Figure 3: Geographical map of the Rio Santa River Basin in the High Andean Mountains; the region has been subject to numerous localized water conflicts in recent years.[278]

El Nino & La Nina: *El Niño and La Niña are opposite phases, known as the El Niño-Southern Oscillation. La Niña is known as the cold phase and El Niño as the warm phase. They occur due to the fluctuations in temperature between the ocean and atmosphere in the east-central equatorial pacific. El Niño and La Niña periods typically last nine to 12 months, but some prolonged events can last for years.[279]*

While an increase in localized water conflicts is expected to occur, scholars remain uncertain about the likelihood of increased inter-state conflict. Jose Esteban Castro, a professor at Newcastle University, argues that chances for inter-state military confrontation over water are slim, and that conflicts are expected to remain regional.[280] The key concern relating to water conflict is that as climate change aggravates availability and accessibility, the likelihood of conflict will increase.

[277] Barbara Lynch, "Vulnerabilities, Competition and Rights in a Context of Climate Change Towards Equitable Water Governance in Peru's Rio Santa Valley," *Global Climate Change* 22 (2012): 367.
[278] Ibid, 367.
[279] United States Department of Commerce, "El Niño and La Niña are complex weather patterns resulting from variations in ocean temperatures in the Equatorial Pacific," *National Ocean Service*, Revised 2013. http://oceanservice.noaa.gov/facts/ninonina.html.
[280] Jose Esteban Castro, "Water Struggles, Citizenship and Governance in Latin America," *Development* 51 (2008): 75.

Water conflicts will have a substantial impact on both human security and regional water scarcity. Additionally, illegal diversion and use of freshwater resources by industrial actors has had a profound impact on downstream agriculture, accessibility, water quality, and energy production.[281]

Water Availability and Accessibility

Availability and accessibility remain among the most important concerns regarding water security in the LAC in light of climate change. Since accessibility and availability are of concern already, the effects that climate change might have on the hydrological cycle are likely to exacerbate existing concerns even under optimistic climate change projections. While water availability and accessibility in the LAC varies regionally, it remains a constant concern across the continent. Accessibility and availability will suffer pressure from both the supply side and the demand side of water resources. When discussing the supply-side of water resources, this includes consequences of climate change and the reduction or increase in availability of hydrological resources and factors such as environmental degradation and pollution. Both will compromise the amount of water available for human applications in the LAC. [282] The demand-side pressure on water resources refers to changes in population growth and resultant industrial, agricultural, and environmental demands. [283]

Guatemala exemplifies the relationship between supply and demand for water resources in the context of climate change. While Guatemala has plenty of natural water resources, the uneven distribution of those resources along with uneven population distribution challenges water access and availability in many areas of the country. [284] For instance, surface water is unevenly distributed in Guatemala. [285] The physical effects of climate change will exacerbate this as hydrological cycles, which will be impacted regardless of the degree of temperature change, become unstable .In 2001, the Guatemalan Government submitted a report to the United Nations Framework Convention on Climate Change[286] raising its primary concerns with climate change, and water security in particular. [287] Climate science projections indicate that changes in the magnitude of the seasonal cycles of precipitation and temperatures will occur. In general, Guatemalan climate trends indicate that the number of hot and dry days is increasing, and the dry season is drier and lasting longer.[288] Moreover, increased incidence of heat waves is likely to produce more

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[281] Anthony Bebbington et al, "Federating & Defending: Water, Territory and Extraction in the Andes," in *Out of the Mainstream: The Politics of Water Rights and Identity in the Andes*, ed. by Rutgerd Boelens et al, (London: Earthscan, 2011): 312

[282] Nigel .W Arnell, "Climate change and global water resources", *Global Environmental Change 9 (1999):* 31.

[283] Ibid, 32.

[284] WaterWiki, "Guatemala", March 7, 2011, http://waterwiki.net/index.php/Guatemala.

[285] Ibid.

[286] Global Faculty for Disaster Reduction and Recovery, "Vulnerability, Risk Reduction and Adaptation to Climate Change," Guatemala 2011, Accessed March 13, 2013.

[287] Ibid, 2.

[288] Ibid, 5.

droughts and expand the semi-arid areas of the country.[289]Additionally droughts in the "*Corredor Seco*," the dry corridor, which encompasses six of the twenty-two departments, will continue to increase in severity and duration. [290] In 2009, the *Corredor Seco* experienced an intense drought, which resulted in over US$ 30 million in economic losses and exacerbated the Guatemalan food crises.[291] These changes in precipitation and temperature are sure to decrease the supply-side of water availability and to increase stress on the demand for water resources.

In the context of decreased availability, water demand will only increase with population growth. Guatemala has the largest population in Central America[292], with rural populations representing half of the total population. It is likely that a large number of Guatemalans will be forced to move to urban centers or migrate as a result of changes in agricultural production and crop yields [293], thereby increasing stress on water resources in urban cities. Like many other Latin American countries, Guatemala is characterized by a large percentage of the population, nearly half, living in high levels of poverty.[294] At least forty percent of the rural population has no household water connection, making rural populations extremely vulnerable to more frequent and severe of droughts.[295]

Water use in Guatemala is distributed among three primary sectors with 80% of water resources being used by the agricultural sector, 13% industrial and 7% for the domestic sector.[296] The availability of water for the agricultural sector is based primarily on surface water; however, the effects of climate change are projected to challenge this, forcing farmers to use groundwater water. This is problematic as surface water provides nearly 70% of the public water demands in urban areas and 90% in rural regions.[297] The projected increase is demand on water availability in part due to population growth and in part due to decreases in resources as a result of climate induced changes will undoubtedly have significant impacts of the livelihood of Guatemalans and other people in Latin America.

While this section focuses on Guatemala, the problems that face Guatemala are already present in many countries of the LAC, and are likely to appear in others as climate change progresses.

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[289] Ibid, 5.
[290] Ibid, 8.
[291] Division for Ocean Affairs and the Law of the Sea Office of Legal Affairs, *Climate Change and the Protection of Guatemalan Marine-Coastal Ecosystems,* (New York, 2011), 12.
[292] Guatemala's population has exceeded 14 million people as of 2011, with an annual growth rate of 2.5 percent (Population Reference Bureau, "Guatemala: Beyond the Early Phase of the Demographic Transition" 2013, http://www.prb.org/Publications/Datasheets/2011/world-population-data-sheet/guatemala.aspx.)
[293] Ibid.
[294] Ibid.
[295] Inter American Development Bank, *Country Program Evaluation: Guatemala,* (2007), 8.
[296] WaterWiki, "Guatemala", March 7, 2011, http://waterwiki.net/index.php/Guatemala.
[297] Ibid.

(2) PROJECTED IMPACTS OF CLIMATE CHANGE ON AGRICULTURE

Latin America encompasses a large area composed of many unique topographies, vegetation zones, and soils. Therefore climate change is likely to have heterogeneous impacts on agriculture in the region depending on crop type, soil type, latitude, altitude, and economic agents.[298] The latest climate models reveal a ten percent average increase in precipitation in north-eastern Ecuador, Peru, and south-eastern South America, and a drop in rainfall in eastern Amazonia, the northeast of Brazil, the central-northern parts of Chile, and most of Central America.[299] Although the intensity of precipitation is expected to increase in general, dry spells between rainy periods will become longer, meaning that opportunities to store water arise less frequently and become more critical for agriculture.

In Paraguay, under global emissions scenario A2 (a high emissions scenario), significant reductions in wheat and cotton yields are predicted by 2030, with soy production decreasing significantly by 2050.[300] Under a low emissions scenario, countries situated in the southern region of the continent, such as Argentina, Chile, and Uruguay could see temperatures rise by between 1.5°C and 2°C over the period 2030-2050, generating possible positive effects in agricultural productivity.[301] However, with any warming beyond this threshold, which is likely to occur under probable emissions scenarios, agricultural productivity will turn negative overall in southern Latin America. Various models, that take into account both high and low GHG emissions scenarios and controls for adaptive measures, show that it remains likely that the effects of climate change will reduce future yields of major crops like wheat, coarse grains, and soy beans in Latin America.[302] **(Figure 4 and 5)** Projected crop yield reductions are likely to result in substantial negative economic impacts, particularly for countries like Argentina and Brazil that are heavily invested in wheat, and coarse grain production.[303]

As the agricultural sector usually accounts for a higher percentage of GDP in developing countries than in developed countries, a certain percentage decrease in agricultural productivity leads to relatively higher losses.[304] In South America, agriculture accounts for 8.6% of GDP, and uses approximately one-third of the

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[298] Gustavo Necco Carlomano, "Impactos Potenciales del Cambio Climatico en la Seguridad Regional en America Latina," *Friedrich Ebert Stiftung* (2012): 27.
[299] Ibid, 24.
[300] United Nations, *The Economics of Climate Change in Latin America and the Caribbean: Summary 2009*, (2009), 28.
[301] Ibid, 28.
[302] Fernandes, et al., *Climate Change and Agriculture in Latin America, 2020-2050: Projected Impacts and Response to Adaptation Strategies* (Washington, DC: World Bank 2012): 39.
[303] Ibid, 56.
[304] N. Stern, *The Economics of Climate Change*, Cambridge, UK: Cambridge University Press, 2007, 108.

terrestrial area.[305] Thus, climate change is likely to negatively impact the Latin American economy as a result of a downturn in agricultural productivity, and an overall reduction in the value of land. The exact impact is difficult to predict, as it is highly dependent on future global GHG emission levels, and regional adaptability to these conditions. If global warming is mild, then the impact will likely be small.

In sum, climate change is likely to negatively impact the Latin American economy as a result of reduced agricultural productivity, and an overall reduction in land values. [306] However, if high emissions scenarios come to pass, where average temperatures rise more than 2 degrees Celsius, which seems likely, Latin American farmers could lose up to 50% of their net revenue by the end of this century.[307]

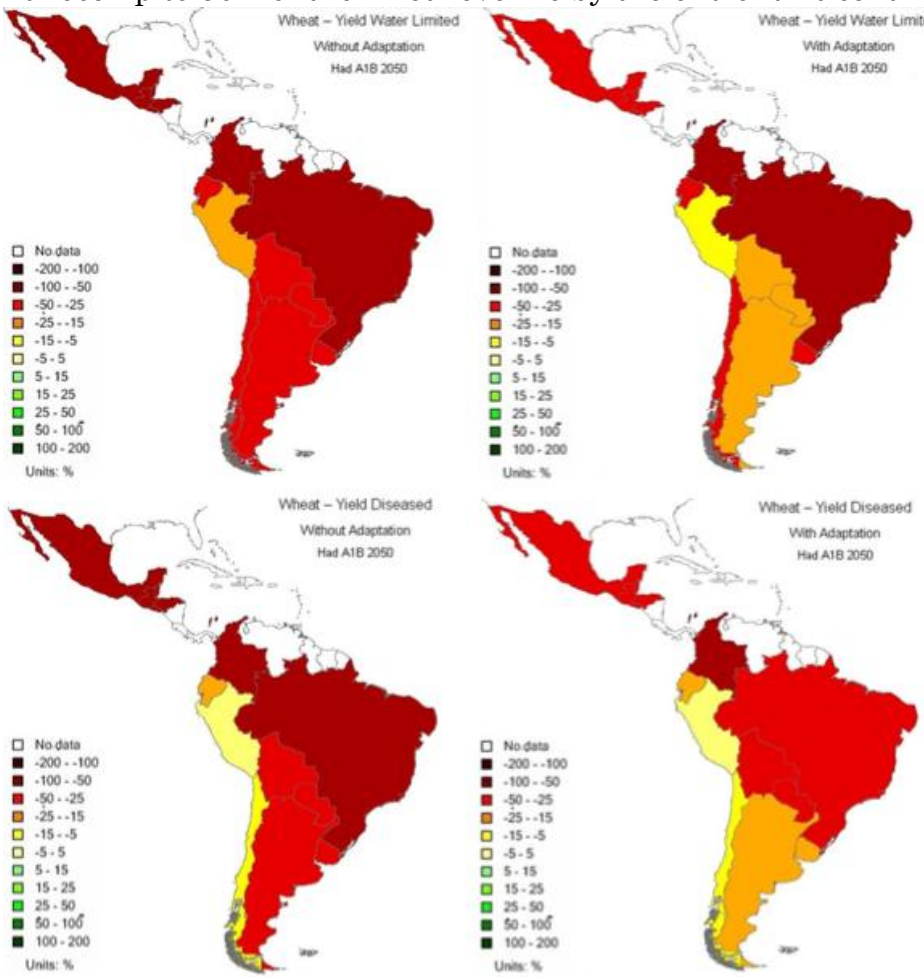

Figure 4 – Map of Latin America showing wheat productivity shocks as a result of climate change under Hadley A1B scenario in 2050 (a lower emissions scenario characterized by a balance across energy source usage). With adaptation the negative impacts of climate change on wheat production can be mitigated in certain regions.[308]

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[305] S. N. Seo and R. Mendelsohn, "A Ricardian Analysis of the Impact of Climate Change on South American Farms." *Chilean Journal of Agricultural Research* 68 (1), (2008): 69.
[306] Ibid, 77.
[307] Ibid, 77.
[308] Erick Fernandes, et al. *Climate Change and Agriculture in Latin America, 2020-2050: Projected Impacts and Response to Adaptation Strategies*. Washington, DC: World Bank (2012): 41.

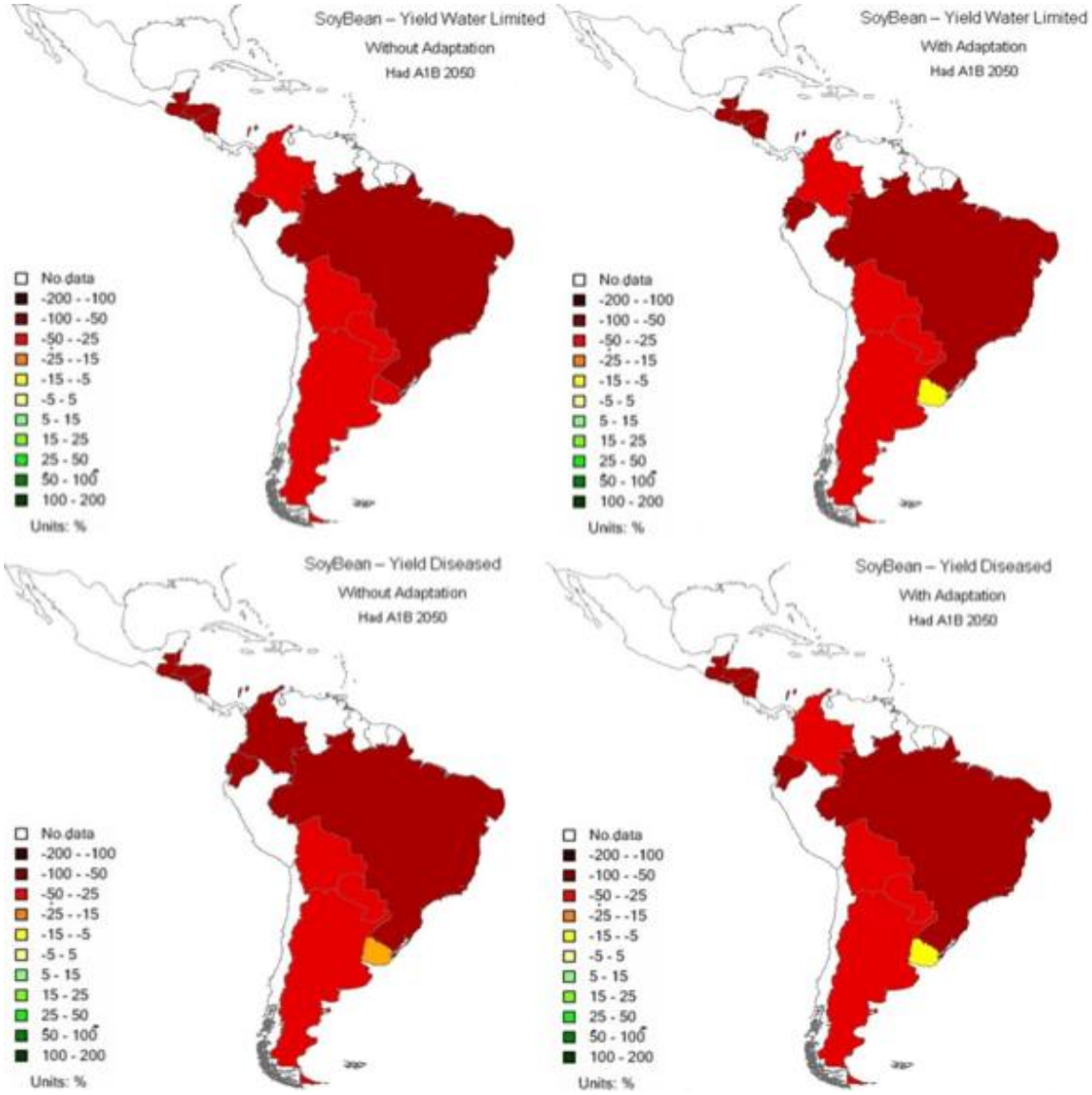

Figure 5 Map of Latin America showing soybean productivity shocks as a result of climate change under Hadley A1B scenario in 2050 (a lower emissions scenario characterized by a balance across energy source usage). Even with adaptation the negative impacts of climate change on soybean production remains virtually the same throughout Latin America.[309]

Notable Uncertainties with Projections

While there is a consensus that the agricultural productivity of Latin America will be negatively impacted by climate change, there are many other input elements that impact agricultural productivity whose relationship with a warming climate we cannot yet accurately predict. They include: how pests and diseases will respond to a warming climate, how CO2 fertilization will be impacted, changes in water

[309] Ibid, 44.

availability owing to remote climate changes, sea-level rise, and ozone damage.[310] While a basic scientific understanding of these factors has been achieved, climate models have not accounted for them to such a degree that their true impact on overall agricultural production can be appreciated.[311]

Vulnerability

Both small household farms and large commercial farms are highly vulnerable to the physical effects of climate change, though in different ways.[312] Studies have shown that large-scale commercial farms equipped with irrigation systems are vulnerable to shifts in patterns of rainfall whereas rural farms are more vulnerable to dramatic increases in temperature.[313] The loss of substantial net revenue from climate change is likely to reduce rural incomes substantially over the coming century.[314]

(3) ENCLOSURE TRENDS IN LATIN AMERICA

In the last three decades, Latin America has witnessed aggressive governmental implementation of policies that favor extractive exploitation of water resources and agro-export companies.[315] This has resulted in the accumulation and concentration of natural resources in the hands of large corporations at the expense of water security and food security. Ecuador serves as a classic example of resource monopolization by agribusiness. In recent decades, Ecuador has witnessed marked increases in the quantity of water used to irrigate profitable crops for export like bananas, coffee, asparagus, pineapple, and sugar cane.[316] In Ecuador, and many other South American countries, water is plundered by agribusiness in two ways: formally, through concessions or authorizations granted by the government, or illegally.[317] In Ecuador, the private sector, representing one percent of agricultural production units, has amassed sixty-seven percent of the water.[318]

In the last decade, multinational Latin American agribusinesses have been concentrating agriculturally productive land by purchasing, or signing long-term leases for large tracts of land within Latin America.[319] These findings have

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[310] Jemma Gornall, et al. "Implications of Climate Change for Agricultural Productivity in the Early Twenty-First Century." *Philosophical Transactions of the Royal Society B* 365(1554), (2010): 2980-2983.
[311] See Gornall, et al, for a more thorough explanation of what contemporary science understands about these input elements and what it cannot yet account for.
[312] Seo and Mendelsohn, 77
[313] Ibid, 77.
[314] Mendelsohn, et al, "Climate and Rural Income," *Climate Change* 81 (2007): 117.
[315] Rutgerd Boelens, et al. "Threats to a Sustainable Future: Water Accumulation and Conflict in Latin America." *Sustainable Development Law and Policy* 12(1), (2011): 45.
[316] Ibid, 42.
[317] Ibid, 42.
[318] Ibid, 42.
[319] Saturnino M. Borras, et al, "Land Grabbing and Global Capitalist Accumulation: Key Features in Latin America." *Canadian Journal of Development Studies* 33, (4), (2012): 413.

challenged old paradigms that land grabbing[320] occurs mainly in fragile states marked by weak governance where corruption and non-transparency characterize land deal.[321] Furthermore, the fact that multinational Latin American companies are grabbing land within Latin America challenges the common notion that there is always a relationship between land grabbing and foreign capital.[322]

In the context of climate change, land and water grabbing are important trends to study because they can have a variety of impacts on water security. Among the driving factors behind land-grabs are concerns related to food security. By 2050, the world population is projected reach 9.1 billion, and climate change is expected to have negative impacts on agricultural production, which could make feeding such a large population a challenge. Expert estimates suggest that, for a 40% increase in world population, food production would need to increase by 70%.[323] Thus, land grabbing has become popular among multinational companies and foreign governments because changes in global supply and demand for agricultural commodities point to a likely increase in land values in the long term.[324] Therefore, large-scale foreign investment in land by agribusinesses is a rising trend because the implications of climate change for water and food security mean that agriculture is likely to be an increasingly lucrative industry.

While land grabbing usually receives a negative connotation, initial evidence indicates that the incorporation of peasants, rural labourers, and indigenous peoples into the emerging commercial farms, commodity chain, and industrial plantations, is more common in Latin America than elsewhere in the developing world.[325] So, while land grabbing occurs in the LAC region within the same logic and processes of global capitalist development that has underpinned land grabs elsewhere, it seems possible that land concentration in Latin America may take different forms and bring opportunities to populations occupying those lands rather than marginalize them. Recently, both Brazil and Argentina have passed legislation that seeks to prevent foreign land-grabbers from monopolizing natural resources, by making them more accountable to host country laws.[326] In Argentina, Law 26, 737 sets a limit on the amount of agricultural land that foreign companies, governments, or domestic companies under foreign control can acquire and makes the rules these actors must comply with more clear so that if they are found in violation of them they risk losing protection of their investments under international law.[327] Whereas Brazil and

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[320] Land-grabbing is defined by Borras, et al, as a process by which foreign capital is invested in the purchase or long-term lease of a parcel of land in excess of 1000 hectares that has a negative impact on the food security of the country losing control of the use of the land.
[321] Borras, et al, 413.
[322] Ibid, 867.
[323] Lorenzo, Cotula, "The International Political Economy of the Global Land Rush: A Critical Appraisal of Trends, Scale, Geography and Drivers," *The Journal of Peasant Studies* 39 (3-4), (2012): 663.
[324] Ibid, 666.
[325] Saturnino M. Borras, et al, "Land Grabbing in Latin America and the Caribbean," *The Journal of Peasant Studies* 39 (2012): 847.
[326] Nicolás Marcelo Perrone, "Restrictions to Foreign Acquisitions of Agricultural Land in Argentina and Brazil," *Globalizations* 10 (1), (2013): 205.
[327] Ibid, 208.

Argentina are middle-income developing countries with strong national governments and legal institutions, other countries in the region are more fragile and are less likely to enact similar legislation. Thus, land grabbing needs to be closely monitored in Latin America, to improve the region's water security, and to prevent the foreign enclosure of agricultural production in the region.

Water Supply & Sanitation

A clean water supply and proper sanitation are essential to modern societies. Climate change presents a variety of challenges for countries in Latin America that are currently battling the problem of reduced clean water and increasing concentrations of waterborne disease.

In 2000, 189 countries adopted the Millennium Development Goals, which included ensuring access to adequate water sanitation, and halving the number of people without access to water suitable for human consumption by 2015.[328] To achieve this goal in the LAC region, improved drinking water and sanitation will have to be provided to over 120 million people.[329] The World Bank definition of clean drinking water requires that many standards be met. The first standard is that access to an improved water source is available to the majority of the population with reasonable access to an adequate amount of safe water. In urban areas the source can be a public fountain or standpipe located not more than 200 meters away from one's home.[330] In rural areas, the definition states that members of a household should not have to spend a disproportionate part of the day retrieving water. Second, an adequate amount of water (20 liters) per person per day is required to satisfy basic hygienic and domestic requirements.[331] The World Bank also suggests that access to improved sanitation facilities should be dramatically improved. Sanitation facilities should provide the population with at least adequate excreta disposal facilities that can effectively prevent human, animal, and insect feces from coming into contact with water used for consumption. Such facilities range from protected pit latrines to toilets with sewerage.

Climate change will cause additional challenges in the achievement of goals pertaining to access to safe drinking water. Declining rainfall in certain areas as a result of climate change, coupled with increasingly frequent droughts and flooding, will affect both the availability and the quality of water.[332] Climate change is likely to negatively impact the achievement of the MDG with respect to improving the number of people globally that have access to safe water for consumption. This is because it is

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[328] WHO Library Cataloguing, "Meeting the MDG drinking water and sanitation target: the urban and rural challenge of the decade," World Health Organization and UNICEF (2006).
[329] Jennifer Frica and Tyler Martz, "The Impact of Climate Change on Water, Sanitation, and Diarrheal Diseases in Latin America and the Caribbean," Population Reference Bureau (2007), http://www.prb.org/Articles/2007/ClimateChangeinLatinAmerica.aspx.
[330] UNEP, "Water Supply and Sanitation Coverage in UNEP Regional Seas, Need for Regional Wastewater Emission Targets": 3-4.
[331] Ibid, 7.
[332] Jennifer Frica and Tyler Martz, "The Impact of Climate Change on Water, Sanitation, and Diarrheal Diseases in Latin America and the Caribbean."

likely to increase water scarcity, which will increase the cost of providing sanitation. The urban poor, who are among the most vulnerable, are likely to be the most negatively affected by increased difficulties of providing sanitation.[333] This is particularly significant in Latin America, where a majority of the population lives in urban areas. The physical effects of climate change, such as increased flood and drought events, and changes in precipitation and temperature extremes, will increase water scarcity, contamination of drinking water, and ultimately exacerbate the spread of disease.[334]

The greatest problem that dirty water can pose is an increase in cholera and diarrhea.[335] Climate change is likely to increase the probability of these diseases occurring in two major ways. The first is the contamination of water supply by tropical storms and flooding. The second is the damage to infrastructure that is essential to water sanitization. These two impacts often occur together.[336]

Approximately 60% of people living in the LAC region reside in coastal states or provinces, with 60 of the region's 77 largest cities found along the coast.[337] Between 1970 and 1999, 30 natural disasters in the LAC region involved hurricanes, floods, droughts, or tsunamis, all of which contributed to increases in waterborne illnesses such as diarrhea. While natural disasters can be frequent occurrences, even a slight increase in the global average temperature may increase their strength and destructive human impact. A minimum sea surface temperature of 26 degrees Celsius is needed for hurricanes to form, but a sea temperature of 27.8 degrees Celsius will cause hurricanes to strengthen in intensity. Given that the lower emissions scenario predicts an increase of 2-3 degrees, hurricane strength may likely increase.[338] The geographic vulnerability of a large portion of LAC to hurricanes, combined with the effect of climate change is likely to contribute to more hurricanes that can damage water supplies. In addition, there is concern that climate change will increase the frequency and severity of El Niño events, which often causes regional flooding and damage to the water supply in some areas. Several researchers have established a link between heavy rainfall and flooding and subsequent outbreaks of infectious diseases.[339] Finally, rises in sea level due to increased temperatures can lead to coastal flooding, which can force the use of contaminated water, overwhelm sanitation systems, or prompt migration into areas with already problematic water security.[340]

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[333] Ibid.
[334] United Nations, "Advances in Environmentally Sustainable Development in Latin America and the Caribbean," Millennium Development Goals, United Nations. 2009, 58.
[335] Jennifer Frica and Tyler Martz, "The Impact of Climate Change on Water, Sanitation, and Diarrheal Diseases in Latin America and the Caribbean."
[336] Ibid.
[337] Ibid.
[338] Paul R. Epstein, "Climate Change and Human Health," *New England Journal of Medicine* 353(14) (2005): 1434.
[339] Jennifer Frica and Tyler Martz, "The Impact of Climate Change on Water, Sanitation, and Diarrheal Diseases in Latin America and the Caribbean."
[340] Ibid.

Case Example: Haiti

The challenges faced by Haiti serve as an example of how the effects of climate change on water supplies in Latin America can exacerbate impacts on an impoverished state with weak water sanitation infrastructure and poor governance. In 2010, Haiti experienced an outbreak of cholera after being struck by an earthquake. Haitian cholera outbreaks worsened after Hurricane Sandy struck the island less than two years later.[341] More than 250,000 cholera cases and almost 5000 deaths due to cholera have been reported in Haiti since October 2010.[342] The flood-prone Haitian city of Gonaïves faces many water sanitation challenges as a result of the increased incidence of flooding and hurricanes in the region. It is susceptible to flooding both from the mountains and from the sea. Based on a sample of 18,290 individuals, watery diarrhea afflicted 10.8 percent of the population in Gonaïves.[343] The already poor sanitary conditions were exacerbated by the earthquake and hurricane of 2009 and 2010, which contributed to the rapid spread of cholera.[344] Increases in cholera and diarrhea particularly impact young children. Infant deaths in Haiti have totaled approximately 7000 since the 2010 outbreak.[345]

Regional Implications & Policy Recommendations: Migration

One of the most significant implications of climate induced water insecurity for the LAC region is the movement of populations. In the LAC, urbanization was rapid between 1950 and 1990. The region went from 40% of the population living in cities at the beginning of this period to 70% forty years later. Since the 1990s, urban populations continued to increase but at a progressively slower pace. Forecasts indicate that this deceleration will continue into the future and that the proportion of urban population will approach 90% by 2050.[346] The potential impacts of climate change on water security could affect the pace of urbanization in the LAC region in ways that are difficult to quantify.

Currently, 55% of rural areas in Latin America do not have access to improved sanitation facilities and many more lack access to other government services [347] With agricultural productivity likely to be negatively impacted by climate change, rural populations that are economically dependent on agriculture will increasingly seek to

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[341]Epicentre Cholera Haiti Working Group. "Population based retrospective survey to assess morbidity and mortality due to cholera in Haiti".
[342] Ibid. This initial cholera outbreak actually occurred due to the presence of United Nations troops from Nepal.
[343] Ibid.
[344] UNICEF. "One year after Hurricane Jeanne, recovery continues," United States Agency for International Development Haiti – Storms Fact Sheet #10, (2008).
[345] "Cholera," BBC Health,. http://www.bbc.co.uk/health/physical_health/conditions/cholera.shtml (Accessed March 20, 2013).
[346] United Nations Human Settlement Programme, "The State of Latin American and Caribbean Cities 2012: Towards a New Urban Transition," 17.
[347] World Bank, "Rural Water Supply and Sanitation Challenges in Latin America for the Next Decade," Lima, Peru: Water and Sanitation Program (2011) http://www.wsp.org/sites/wsp.org/files/publications/WSPLACRural-Water-Sanitation-Next-Decade.pdf, 14.

move to urban centers where the economy is more diverse. This will present additional challenges to existing problems in the region's urban areas.

In 2010, more than 10 million urban dwellers in LAC still did not have access to improved water resources, and 75 million did not have access to improved sanitation facilities.[348] If urbanization of the LAC region returns to a fast pace it is likely that this will only exacerbate the water security challenges that urban centers in the region already face by placing more pressure and demand for water services on municipalities. People affected by natural disasters and subsequently contract water borne illnesses often migrate in an effort to find relief, which can lead to cholera spreading.[349] Cholera outbreaks in Haiti have spread to the Dominican Republic, Venezuela, Cuba, and Florida, demonstrating that water borne diseases can affect nearby countries, and as such, are a concern for the international community.[350]

After decades in which central governments and local authorities in the LAC seemed unable to cope with change processes that were too fast, they have now brought together, in principle, all the requirements needed to achieve sustainable urban development in the years and decades to come.[351] Regionally urbanization is decelerating, the general economic outlook is encouraging, and social policy has improved, which means that currently more than ever in the past Latin America has an opportunity to address the problems that plague their urban areas. One of the most concerning issues for the LAC is inequality in urban centers. Although the proportion of people living in urban slums has decreased in the last twenty years in the LAC, in absolute terms the number has increased to 111 million.[352] While widespread access to water and sanitation has been achieved, the poor generally still pay more for a lower-quality water service with frequent delivery cuts.[353] Moreover, there are severe limitations in terms of the affordability and financial sustainability of the municipal services provided, as these aspects do not seem to have received enough attention.[354]

Problems associated with climate change, water insecurity, and urbanization in the LAC is of concern to Canada. If potential problems arising from urbanization are not dealt with in the near future, it becomes more likely that people living in the LAC region will seek to leave the region altogether, with the U.S. and Canada being likely destinations. Due to Canada's proximity to the LAC, this is an important implication to consider. According to Statistics Canada, the Latin American community is one of the fastest growing cultural groups in Canada. [355] Naturally, an increase in Latin American migrants to Canada is expected in light of the projected

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[348] United Nations Human Settlement Programme, "The State of Latin American and Caribbean Cities 2012: Towards a New Urban Transition,"81.
[349] Frica, Jennifer and Martz, Tyler.
[350] "Cholera outbreak," BBC, http://www.bbc.co.uk/news/world-latin-america-18696660 (accessed March 19, 2013).
[351] Ibid, xi.
[352] Ibid, xii.
[353] Ibid, xiii.
[354] Ibid, xiii.
[355] Statistics Canada. *Profile of Ethnic Community in Canada*, March 13, 2013, http://www.statcan.gc.ca/pub/89-621-x/89-621-x2007008-eng.pdf, 35.

physical effects of climate change. However, if Canada can support initiatives in the LAC region to adapt to climate change before people residing in the region desire to leave in large numbers, this would be a useful policy for Canada to adopt. Specific actions that Canada might take include: lending expertise or financial assistance in the fields of urban planning, water infrastructure improvement, and making the transition from an economy oriented towards agriculture and manufacturing to a service oriented economy.

Socio-Political Destabilization

Water insecurity as a result of climate change is likely to have destabilizing impacts on countries in the LAC that are already fragile as a result of socio-political problems. As many LAC states are characterized by high crime rates, large income disparity, narco-trafficking, and political instability, the physical consequences of climate change are likely to further exacerbate socio-political challenges within the region. [356] Consequentially, poor water security could contribute to crises that result in conflict and/or reactions to government incapacity or failures, particularly as state capacity varies significantly in the LAC. Furthermore, instability as a result of climate induced water insecurity could lead to increased environmental degradation that could serve to repeat the disruptive cycle. [357] Thus, adaptation to climate induced water insecurity is essential to avoid compounding socio-political problems that the region already faces. It is in the Canadian national interest to promote respect for the rule of law, democracy, and environmental sustainability in Latin America and the Caribbean to strengthen the region and thereby improve our own security and economic prosperity.

(4) CONCLUSION

The most significant implications of climate induced water insecurity that are likely to develop in the LAC region under high emissions scenarios include challenges regarding urbanization, migration, and socio-political stability. Canada will not be able to remain isolated from these implications because it shares close economic and political relations with countries in the LAC and receives a high proportion of its immigrants from the region. Pressures occurring in the LAC as a result of climate change will demand attention from the Canadian government and from international organizations in which we participate.

Currently, the Canadian International Development Agency's (CIDA) Inter-American Regional Program commits to supporting 33 countries in LAC[358] and it is likely that climate change will make certain countries in region more dependent on

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[356] Alexander Carius, and Maas Achim, "Climate Change and Security: Three Scenarios for Middle America," Brussels: European Commission (2009): 9.
[357] Ibid, 10.
[358] CIDA, "Inter-American Regional Program- Overview", Last modified October 19, 2012, http://www.acdi-cida.gc.ca/acdi-cida/ACDI-CIDA.nsf/En/JUD-82413253-NF8.

assistance. However, based on recent announcements by the Harper government that CIDA will be folded into the Department of Foreign Affairs, International Trade and Development (DFAIT), it seems that Canada is moving towards tying its economic interests more explicitly to its aid operations.[359] The announcement has raised concerns that this will narrow the scope of Canadian aid such that it focuses on Canadian commercial interests and loses sight of the fact that aid is meant to benefit the developing country to which it is given, not the donors special interests.[360] Canada's mining industry is active throughout the LAC and would likely be an industry that DFAIT would seek to support by allocating aid to regions where Canadian mining interests were at stake. Should Canadian aid operations become tied more directly to economic interests it could have negative impacts on water security in the region because aid will less frequently tackle the issues of greatest importance to people in the wider region of Latin America. It is more likely that Canadian aid will assist communities where commercial interests are at stake, and where the issues of greatest importance in light of climate change (migration, socio-political instability) are not as much at stake.

The relationship between climate change, development, and water governance is at a crossroads in the LAC region. Most of the countries in the region have higher adaptive capabilities than countries in Africa and Asia, but some, especially in the Caribbean and Central America, require external assistance to implement adaptation strategies for climate change. It is critical that Canada supports initiatives that benefit the human security of Latin American countries in advance of the worst physical consequences of climate change because adaptation will be less costly if it is pursued now rather than in the future and the benefits will be greater.

[359] Kim Mackrael, "With CIDA's Demise Canada Takes a New Approach to Foreign Aid," *The Globe and Mail* (March 22, 2013) http://www.theglobeandmail.com/news/national/with-cidas-demise-canada-takes-a-new-approach-to-foreign-aid/article10254764/

[360] Daniel Schwartz, "Should International Aid Serve Canada's Commercial Interests?" *CBC News* (March 28, 2013), http://www.cbc.ca/news/canada/story/2013/03/27/f-cida-dfait-merger.html.

ASIA

Climate Change, Water Security, and Asia

Asia (Pakistan, India, Bangladesh, Nepal, China, and South East Asia) is one of the most populated places on the planet. As urbanization, industrialization and population each expand throughout this region, the demand for water will also increase. The Tibetan Plateau, as the origin of South Asia's complex network of rivers, increasingly experiences the negative effects of climate change. This section will examine regional projections on how climate change will affect the major rivers and their basins that draw their source from the Tibetan Plateau. Diminishing water supplies, combined with increasing demand for water is likely to exacerbate tensions between South Asian states and could be a potential source of future conflict in the region if policies of cooperative mitigation and adaptation are not implemented. Such policies can be enforced through an emphasis on better water basin management and cooperation through international governance of such water basins. The ensuing sections will consider the relevance of each region's growing water concerns to Canadian values and interests.

This section will focus on the effects of climate change on water availability in the Tibetan plateau region and the states directly affected by glacial melt within this region. With an average elevation of 4500m above sea level, the Tibetan Plateau holds the Hindu Kush Himalayan ice sheet, considered to be the largest ice mass and fresh water reservoir outside of the Earth's poles, and has therefore been labeled as the world's "Third Pole".[361] This glacial system directly provides water to those living downstream, including regions with extremely high populations. These areas include China, India and the Southeast Asia mainland.[362] In the eastern Himalayas, the contribution of the melting glacier ice to the downstream river flow is estimated at 5% or less. In the western Himalayas however, the contribution is far greater and may be as high as one-third or more of the total water supply.[363]

Furthermore, this section will explore state compensation strategies in response to the insecurities caused by climate on the Tibetan glaciers. The implications of these strategies on inter-state relations as well as on domestic populations will be examined, especially the consequences of water waste and agricultural technologies, and hydroelectric energy production for the sound development of these regions.

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[361] ---, 2012, "Tibet: The Third Pole, Importance of Environmental Stewardship", Environmental and Development Desk, Department of Information and International Relations (Central Tibetan Administration): 1.
[362] Elizabeth L. Malone, *Changing Glaciers and Hydrology in Asia: Addressing Vulnerabilities to Glacier Melt Impacts*, (USAID, 2010): 2.
[363] Ibid.

(1) CHINA: A FOCUS ON THE YELLOW & YANGTZE RIVER BASINS

Introduction

The aims of this section will be to focus on conditions of water scarcity and stress within China. Particular attention will be paid to the Yellow River Basin and the Yangtze River Basin. Both of these water systems originate from the glaciers of the Tibetan Plateau.[364] Further industrialization in China will increase the demand for water above its current aggregate demand of 420 billion m^3 and a supply of 618 million m^3 of usable water resources.[365] Industrial demand for water is projected to be 265 billion m^3 as a result of an increased need for power and hydroelectricity.[366] Meanwhile, China's overall demand, by 2030 is projected to amount to 818 billion m^3, 50% of which will be allocated towards agricultural productivity; therefore resulting in a projected 25% supply shortfall.[367] Much of China's water supply is wasted through mass inefficiencies in water use. Approximately 20%, or one fifth of the overall supply of usable water, is wasted through such means.[368] Furthermore, China finds its groundwater resources facing rapid depletion and poses a major threat to human security as well as the economic well-being of China.[369] The state is heavily reliant on such resources as it is used in irrigation for over 40% of farmland, and 70% of drinking water in the semi-arid and arid regions to the north and northwest.[370] Much of the issues surrounding groundwater stem from the pressures of climate change and population growth, but ultimately the majority of the issues lie in political mismanagement of the water source which proves to be an overarching issue surrounding water security in China.[371]

The River Basins

The Yangtze River is the largest river in China and the third longest globally, at 6397km. Its basin covers 1.8million km^2.[372] The Yangtze River Delta region, located on the Pacific Coast in northeastern China, has the highest concentration of cities and urban centres in China.[373] This region also possesses a vibrant economic

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[364] Joanna I. Lewis, "China," in *Climate Change and National Security: A Country-Level Analysis*, (Washington D.C.: Georgetown University Press, 2011), 17.
[365] 2030 Water Resources Group, *Charting Our Water Future: Economic Frameworks to Inform Decision Making* (London: McKinsey & Company, 2009), 10.
[366] Ibid, 6.
[367] Ibid, 10.
[368] Joanna Lewis, "Environmental Challenges: From the Local to the Global," in *China Today, China Tomorrow: Domestic Politics, Economy, and Society*, edited by Joseph Fewsmith, (New York: Rowman & Littlefield Publishers inc., 2010), 262.
[369] Jane Qiu, 2010, "China Faces up to Groundwater Crisis," *Nature* 466: 308.
[370] Ibid.
[371] Ibid.
[372] Tong Jiang, Zbigniew W. Kundzewicz, Buda Su, 2008, "Changes in monthly precipitation and flood hazard in the Yangtze River Basin, China," *International Journal of Climatology* 28: 1471.
[373] Guo-Fang Li et al., 2013, "Impact assessment of urbanization on flood risk in the Yangtze River Delta," *Stochastic Environmental Research and Risk Assessment* 27(2): 461.

sector which in turn fuels rapid urbanization.[374] The Yellow river flows through nine Chinese provinces and stretches 5464 km, with a basin area of 795,000 km².[375] The water from this river basin, according to 2006 statistics supported a population of 140 million people, or 10% of China's population.[376] Water use in this area has tended to be used inefficiently, through poor irrigation technologies that have strived to support nearly 6.6 million hectares of cultivated dry land in the Yellow River Basin.[377]

Figure 1: China's River Basins

Source: http://wwf.panda.org/about_our_earth/about_freshwater/freshwater_problems/river_decline/10_rivers_risk/yangtze/

Climate Change, while possibly acting as a threat multiplier, aggravate risks within these regions, including, (but not limited to) precipitation extremes, severe weather events, sea-level rise, glacial melt, as well as an array of implications whose realities will inevitably impact on China's agricultural and economic productivity.[378] For the purposes of this report these changes will be examined in relation to their effect on water stress within the Yangtze and Yellow River basins.

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[374] Ibid.
[375] Claudia Ringler et al., "Yellow River basin: living with scarcity," *Water International* 35(5): 682.
[376] Tetsuya Kusuda ed., *The Yellow River: Water and Life* (Singapore: World Scientific, 2010), 10.
[377] Ibid., 16.
[378] Joanna I. Lewis, "China," in *Climate Change and National Security: A Country-Level Analysis*, (Washington D.C.: Georgetown University Press, 2011), 11.

Precipitation and Severe Weather

Severe weather events are projected to have a substantial impact on these regions. The coastal deltas face the looming threats of monsoon generated storm surges, sea-level rise, as well as instances of drought and intense heat.[379] The mean annual temperature over all of China in 2011 was 9.3°C, which was 0.5°C above the normal when one consults with the 1971-2000 base period.[380] More specifically, the mean number of days with temperatures equal to, or grater than 35°C was 10.6 in 2011. [381]

Variation in precipitation has also been observed throughout China. In 2011, the mean annual precipitation was 556.8mm which is 18% below 2010 levels. Such a drop in precipitation caused 2011 to be the driest year since 1951.[382] Water stress is already apparent in many regions of the Yangtze and Yellow river basins. In the early stages of 2011, the Yellow River basin (along with the Huaihe River basin, to the south of the Yellow River) saw the most severe autumn drought in the last 41 years. Also, the mid-low regions of the Yangtze River basin experienced the most serious drought in the autumn and summer months in the past 60 years.[383] It is also important to note that this prolonged drought in the Yangtze region was abruptly followed by strong floods in June 2011.[384]

Problems of excess precipitation and heavy rainfall were also experienced, although at a reduced rate from previous years. Annual rainstorm days throughout China were 10.3% below normal, the lowest level in 30 years.[385] Despite the overall decline in precipitation, regional increases were noted. For example, precipitation within the Yellow River basin was higher than normal, while Beijing, which relies heavily on the waters of the Yellow River, experienced precipitation 125% of normal levels. These circumstances directly resulted in water logging and inundation throughout this and other major urban centres.[386] Climate change has also had visible effects on the timing of precipitation, which has historically occurred in reliable patterns. The flood season in the Yangtze River basin is marked by an annual 'rain belt' called the "Mei-Yu."[387] In 2011, this event began much earlier than usual. Despite this alteration in the anticipated schedule of precipitation, overall precipitation in the Yangtze River basin was below 1000mm, the lowest since 1979.[388]

Tibetan Plateau Glacial Melt

Glacial melt is anticipated to be the source of much water stress within China and the surrounding region, particularly due to the rapid melting of the Tibetan

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[379] Ibid.
[380] J. Blunden, and D. S. Arndt, Eds., 2012, "State of the Climate in 2011," *Bull. Amer. Meteor. Soc.*, 93 (7): S203.
[381] Ibid.
[382] Ibid., S204.
[383] Ibid., S205.
[384] Ibid.
[385] Ibid., S204.
[386] Ibid., S205.
[387] Ibid., S204.
[388] Ibid.

plateau glaciers. The Tibetan plateau region is experiencing rapid warming and as such poses a security risk to all the countries that rely on its water run-off. The total area covered by the glaciers in the western region of the plateau is anticipated to diminish by 27.2% by 2050.[389] This is crucial because, until water runoff from the glacial melting peaks between 2030 and 2050, it is anticipated to increase its discharge by 20-30% annually.[390] Therefore, it will initially cause flooding of rivers, like the Yellow and the Yangtze, which draw the majority of their water from these glacial sources. However, once the discharge has reached its peak by 2050, drought and severe water scarcity is expected to ensue as the water that supports many millions of people as well as one of the richest agricultural regions in China no longer flows through traditional channels.[391] This will have major impacts on both domestic production as well as Chinese contributions to the international economy.

Domestic and International Security Threats

The most feasible way to address China's overarching water scarcity issues is at the basin, or sub-basin level.[392] This is necessary due to the extreme regional variation within China. A single broad solution beyond a notion of conservation will not be equally effective in all areas. There are various options from domestic supplies that can be utilized depending on the geography of the region. Surface and ground water will remain in use as well as the implementation of substantial transfer and movement of water to stressed areas.[393] Water scarcity may lead China to divert rivers from flowing into nearby states to these stressed areas within China. This has the potential to escalate inter-state tensions and may lead to conflict over equitable access to inter-state waterways.[394] Such initiatives are also present domestically, through the South-to-North Water Diversion Project that attempts to address northern China's water scarcity issues by diverting a portion of the Yangtze River northward.[395] If such ambitions are focused on rivers that supply water to one or more states downstream, water supplies as well as the hydrological systems in these areas would be significantly limited.[396]

Internationally, the potential damage incurred by economic infrastructure, particularly along the coastal river deltas, directly threatens China's economic well-being.[397] It also has a direct impact on China's external trade relations, as any major economic losses incurred by China through the effects of dramatic events rooted in

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[389] Lewis 2011, 11.
[390] Ibid.
[391] Ibid.
[392] *Charting Our Water Future: Economic Frameworks to Inform Decision-Making*, 78.
[393] Ibid.
[394] Lewis 2011, 17.
[395] Zhisong Chen et al., 2013, "Pricing and Water Resource Allocation Scheme for the South-to-North Water Diversion Project in China," *Water Resource Management* 27: 1459.
[396] Anping Chen and Changdu Chen, 2004, "Ecological and Political Costs of River Diversion," *Nature* 429: 501.
[397] Lewis (2011), 19.

climate change will directly trigger changes in other national economies either directly or indirectly tied to China.[398]

Implications for Canada

China is currently Canada's second largest trading partner, while Canada is placed as China's thirteenth largest trading partner.[399] China has noted in its most recent five year plan that this sector is of paramount importance.[400] Hydroelectricity in China is projected to become less feasible as water scarcity increases.[401] Furthermore, as the pressures of a growing Chinese population increasingly strain water and agricultural resources, it is in the interests of the Canadian government to not only see that Chinese export capabilities remain competitive in a global economy, but it also presents an opportunity to invest in joint efforts to develop scientific and technological innovation to better the efficiency of agricultural production.[402] The Yellow River basin, as one of the most productive agricultural sectors of China, should also be on the radar of the Canadian government as somewhere that should receive investment in better agricultural practices and technology.

In terms of the international basin management and governance, Canada should actively advocate for China's involvement in regional initiatives working towards an international framework for water basin management and trans-boundary water governance. Particular emphasis should be placed on pushing the Chinese government to take an active role within the Mekong River Commission in order to mediate any potential water conflicts in the region, and to ensure that China's pursuit of improved water security does not diminish the capabilities of its neighbouring states to do the same.

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[398] Ibid.
[399] Government of Canada, "Canada-China Economic Complementarities Study," Department of Foreign Affairs and International Trade Canada, 2012: http://www.international.gc.ca/trade-agreements-accords-commerciaux/agr-acc/china-chine/study-comp-etude.aspx?view=d
[400] Ibid.
[401] Ibid.
[402] Ibid.

Table 2: Canada-China Merchandise Trade (US$ Billions)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Canada Exports (China Imports)	2.7	2.6	3.4	5.2	6.0	6.9	8.9	9.9	9.7	12.9	17.0
Canada Imports (China Exports)	8.2	10.2	13.3	18.6	24.4	30.5	35.9	39.9	35.0	43.2	48.6
Total	11.0	12.8	16.7	23.8	30.4	37.3	44.8	49.8	44.7	56.1	65.6

Table 2: Canada-China Merchandise Trade (US$ Billions)

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Canada Exports (China Imports)	2.7	2.6	3.4	5.2	6.0	6.9	8.9	9.9	9.7	12.9	17.0
Canada Imports (China Exports)	8.2	10.2	13.3	18.6	24.4	30.5	35.9	39.9	35.0	43.2	48.6
Total	11.0	12.8	16.7	23.8	30.4	37.3	44.8	49.8	44.7	56.1	65.6

Source: Global Trade Atlas (Canadian statistics)

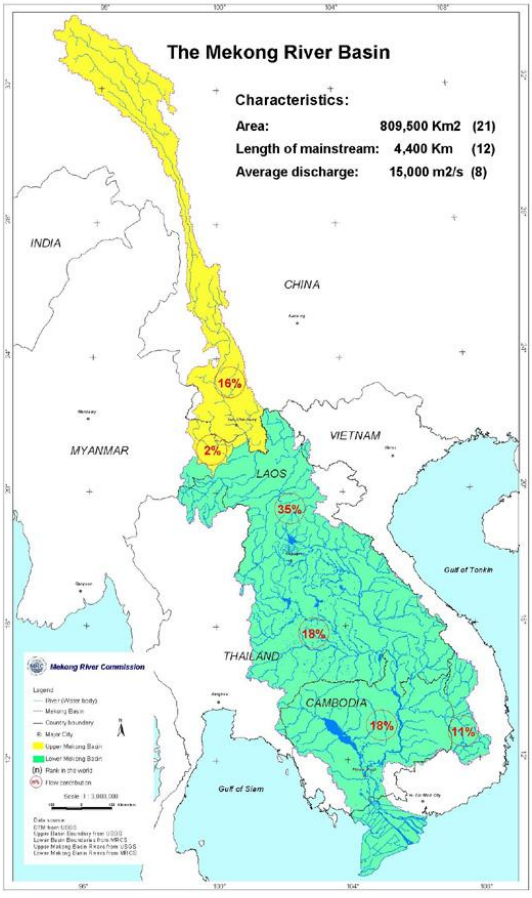
Table 3: Canada-China Merchandise Trade (US$ Billions)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
China Exports (Canada Imports)	3.3	4.3	5.6	8.2	11.7	15.5	19.4	21.8	17.7	22.2	25.2
China Imports (Canada Exports)	4.0	3.6	4.4	7.3	7.5	7.7	11.0	12.8	11.9	14.8	21.6
Total Trade	7.4	7.9	10.0	15.5	19.2	23.2	30.3	34.6	29.6	37.0	46.8

Source: Global Trade Atlas (Chinese statistics)

Source: http://www.international.gc.ca/trade-agreements-accords-commerciaux/agr-acc/china-chine/study-comp-etude.aspx?view=d

(2) A CASE STUDY OF THE MEKONG RIVER



The Mekong River is the 9th largest river in the world and is the most important resource for mainland Southeast Asia. The river has a catchment basin of 800,000 km2. Six countries share the basin; with a combined population of well over 60 million in the Lower Mekong River Basin (LMRB) alone. The river flows from the Tibetan plateau in China to the south coast of Vietnam, passing through or bordering China, Vietnam, Burma, Thailand, Laos and Cambodia. As a tropical climate system, the river is characterized by natural 'flood pulse' hydrology that is associated with annual seasonal variation, particularly during the monsoon seasons. Over the last 30 years, the river has seen negative ecological changes resulting from the effects of global warming, the building of hydroelectric dams, as well as the effects of increasing industrialization and urbanization. Sustainability of the Mekong is one of the greatest challenges facing the countries of

mainland Southeast Asia that heavily rely on the river for water use- Laos and Cambodia, which get 97% and 86% respectively of their water from the Mekong. The diverse utility of the Mekong ranges from agriculture, irrigation and fisheries, to power generation (hydroelectricity), industrial use. Domestic water supply makes this river a significant element for the future sustainability of the economies and livelihoods of the area's millions of inhabitants. Rising temperatures in the region increase the frequency of extreme weather patterns. These include heat waves, droughts, and massive flooding. Such factors have a profound effect on societies in Southeast Asia that depend heavily on agricultural sustainability (particularly in the rice industry) to maintain their economies. Climate change will add to the already existing problems facing the nations that rely on the Mekong River, which include China's dam-building and diversion projects, as well as environmental degradation and pollution of the river source in Tibet. The Mekong River Commission (MRC) has attempted to raise the issues of the international need for water governance of the Mekong; however, the commission is unable to overcome national interests and is missing a vital component - the participation of China.

Climate Change and Water Resources

Mainland Southeast Asia has experienced many changes over the last few decades. Increased urbanization and industrialization have provided many of these countries with strong GDP growth and an opportunity to enter the world market system with confidence. Despite its many advances, mainland Southeast Asia still relies heavily on its agricultural sector. The livelihood of each community is subject to the seasonal variability of weather patterns, thus making this region of the world very sensitive to environmental change. Changing basin hydrology directly threatens agriculture, because of the effects associated with declining food security and rising poverty.[403] The negative consequences of climate change on water supply will considerably affect the agricultural and fishing industry, urban commerce, and the tourism sectors of the region's economy. Thus far, Southeast Asia has been deemed to be relatively safe from the problems of water scarcity; however, this is likely to change in upcoming decades because global warming will continue to shape the hydrometerological processes of the major river basins.[404] Rising sea levels and more frequent severe storms will change the flooding patterns of the region as well as increase the intensity of coastal storm surges; thereby causing harmful inundation of coastal regions and inland rivers.

Despite Southeast Asia's population density being 2.6 times above the global average, water availability has not been overly problematic.[405] Water availability in

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[403] Klairulmaini Osman Salleh, "Climate Insecurity in Southeast Asia: Designing Policies to Reduce Vulnerabilities" in *Troubled Waters* ed. by D. Michel and A. Pandya (The Henry Stimson Center, Washington, D.C., 2009), pp. 36

[404] Ibid, 33-34.

[405] Mukand S. Babel, and Shariar M. Wahid, *Freshwater Under Threat South East Asia: Vulnerability Assessment of Freshwater Resources to Environmental Change, Mekong River Basin*, United Nations Environment Programme. (Nairobi, Kenya, 2009), X.

the LMRB is 5,500m^3 per person per year.[406]However, this measurement is not a true indicator of the realities of water supply in Southeast Asia because the summer monsoon season provides for roughly 80% of the annual runoff in the Mekong River Basin (MRB).[407] Moreover water exploitation in Southeast Asia is very poor, with almost all sub-basins below 30% of potential use. While this presently presents an unfortunate reality that the states in the LMB lack the resources to effectively use water resources, there is optimism that greater state capacity would lead to a drastic increase in water security.[408] Equally alarming are estimates that 38% of the LMRB population lack access to safe-drinking water and that many regions have poor access to improved sanitation facilities; once again this could be subject to great change if the proper development projects are implemented.[409]

Climatology of Southeast Asia, Climate Change and Social Impacts

The climate of Southeast Asia is controlled primarily by the behaviour patterns of the monsoons, as well as numerous oceanic weather patterns such as the El Niño Southern Oscillation (ENSO).[410] Changes in oceanic atmosphere weather patterns may alter the timing of annual weather events, and possibly increase the intensity, frequency, and duration of low-pressure storms, floods, and droughts.[411] The International Panel on Climate Change (IPCC) has found that temperatures in Southeast Asia rose at a rate of 0.1°C to 0.3°C per decade between the years 1951-2000.[412] The region has also seen the extreme weather patterns associated with El Niño, such as drought and tropical cyclones become more frequent and intense in the past 20 years and 30 years respectively.[413] In their predictions of future climate change over the course of the 21st century the IPCC projects that temperatures will increase in LMB another 2.5°C, rainfall will increase 7% on average throughout the region, sea levels will rise 40 centimetres, and tropical cyclones will increase in intensity anywhere from 10-20%[414]

These increases in extreme weather patterns are particularly threatening to low lying coastal communities and river deltas where sea-level rises will cause salt water encroachment resulting in unsustainable crop development and overall damage to the agriculture output of coastal communities, particularly in

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[406] Ibid, 17.
[407] Ibid.
[408] Ibid, 18.
[409] Ibid.
[410] Klairulmaini Osman Salleh, "Climate Insecurity in Southeast Asia: Designing Policies to Reduce Vulnerabilities" in *Troubled Waters* ed. by D. Michel and A. Pandya (The Henry Stimson Center. Washington, D.C., 2009), 36.
[410] Ibid, 35.
[411] Ibid.
[412] Ibid.
[413] Ibid.
[414] Ibid.

Vietnam.[415]A 2007 United Nations Human Development Report, Fighting Climate Change: Human Solidarity in a Divided World estimated that in 20 years 45% of the Mekong River Delta will be exposed to sea water and crop damage through flooding and that by 2050 much of the Delta will be completely inundated for most of the year.[416] Losses in agricultural output will present serious economic, political and social problems. For example, Vietnam's vital rice crops are expected to shrink by 9% as a result of this new environmental change which will require the nation to diversifying or perhaps even completely transform its agricultural sector.[417]

The Threats of Higher Flows for the Mekong River

Unlike many other rivers originating from the Tibetan Plateau, the Mekong River will not face significant reduction in water flow as a result of glacial retreat. The retreat of the Tibetan glaciers will affect the Mekong River in the short term through higher flow rates resulting in greater flooding which can be expected to happen within the next 20 – 30 years.[418] However, the long term consequences of disappearing glaciers are unlikely to substantially impact on the Mekong because overall precipitation in all catchment areas of the river will probably increase as a result of temperature increases in the region.[419] Unfortunately, rising temperatures are likely to offset increases in rainfall through evaporative processes; therefore, increased rainfall is not an adequate indicator of greater water security.[420] Increased variability of the monsoon season also creates many significant challenges for this area.

Future summer monsoon seasons are expected to increase rainfall in Southeast Asia. Furthermore, there is evidence that climate change will destabilize rainfall patterns within summer and winter seasons.[421] The likelihood of suboptimal rainfall in the winter season will cause more arid conditions, while excessive rainfall during the summer is likely to result in intense regional flooding.[422] These factors will certainly have immense implications for crop production and harvesting methods, as precipitation extremes at either end of the spectrum can severely diminish overall crop yields. The largest problem facing Southeast Asia and the Mekong Delta will be a change in the flooding regime due to seal level rise.

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[415] Le Anh Tuan and Suppakorn Chinvanno, "Chapter 12: Climate Change in the Mekong River Delta and Key Concerns on Future Climate Threats" in *Environmental Change and Agricultural Sustainability in the Mekong Delta,* Mark A. Stewart and Peter A. Cochrane eds., *Advances in Global Change Research*, 45 (2011), 212.
[416] Milton Osborne, "The Mekong: Rive Under Threat" Lowy Institute for International Policy, Lowy Institute Paper 27. 2009, 45.
[417] Ibid.
[418] Ibid.
[419] Ibid.
[420] Benjamin L. Preston et al, "Climate Change in the Asia/Pacific Region," Commonwealth Scientific and Industrial Research Organisation (CSIRO Marine and Atmospheric Research), 39.
[421] Ibid, 25.
[422] Ibid.

National Interests Impacts on the Mekong River

As stated above, the impacts of climate change on the Mekong River will be a significant challenge to the already existing multidimensional problems facing the nations that draw from this vital water resource. The river's flow and its health is a trans-boundary issue and should therefore be approached through multilateral institutions that recognize the importance of preserving the river's sustainability. Degradation and mismanagement of the Mekong River threatens its natural flow, which has historically supported the basin's fishing and agricultural industries.[423] More recently, the river has been used for hydropower and has therefore altered the river's reliability as a food source. In China, the riparian landscape in Yunnan province is characterized by sharp drops in altitude and deep gorges, thus making the use of the river more favourable to hydropower than irrigation.[424] In Vietnam, the Mekong River Delta provides for shrimp farms and fisheries that maintain the livelihood of over 18 million people, while the primary water use of the delta is irrigation, generating more than half of the country's annual rice production.[425] In Cambodia, Tonle Sap (Grand Lake) provides a critical spawning place for many important migratory fish species that are caught by commercial fishermen far up the Mekong River.[426]

The creation of dams for power generation is a controversial aspect of water use in Southeast Asia. It is beyond the scope of this paper to examine these aspects of alterations to the Mekong River's flow; however, the main factors that have prevented the MRC from being effective in its goals to provide long-term sustainability of the Mekong River are new demands for electricity and the national self-interest of particular riparian states. Countries such as Vietnam and Thailand are facing the realities of drastic increases in electricity demand, while Laos and Cambodia are interested in using hydroelectricity for exports as a source of foreign exchange.[427] China is already developing a cascade of dams which has contributed to a diminished flow into the LMB, thus causing unprecedented drying of the river. In combination with climate change, this factor will further the fishing industry and agrarian problems already being experienced in the LMB. Canada's involvement in international water governance must realize that these two factors will present an accumulative effect on the future sustainability of the Mekong River.

Canada's Role and Interests

Future considerations for the sustainability of the Mekong River will require an international response that considers the social, economic, and ecological factors of

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[423] Philip Hirsch and Kurt Morck Jensen, " National Interests and Transboundary Water Governance in the Mekong," Australian Mekong Resource Centre (University of Sydney, 2006), 14.
[424] Ibid.
[425] Ibid.
[426] Mukand S. Babel and Shariar M. Wahid, *Freshwater Under Threat South East Asia: Vulnerability Assessment of Freshwater Resources to Environmental Change, Mekong River Basin*, United Nations Environment Programme. (Nairobi, Kenya, 2009), 12.
[427] Gary Lee, and Natalia Scurrah, "Power and Responsibility: The Mekong River Commission and Lower Mekong Mainstream Dams," Oxfam Australia (University of Sydney, October 2009), 11.

a changing global climate system and the effects of socially constructed projects that affect the river. This response should come from all nations that have a vested interest in the river and the preservation of the Mekong as a viable water resource. Canada's interest in international water governance should consider assisting the nations that make use of the river in order to provide the communities of Southeast Asia with the adaptive capacity to respond to the changing ecological aspects of both the region and the Mekong River itself. The growing economies of Southeast Asia also present an opportunity for Canada to diversify its trading relations with these countries which at 2012 levels saw imports from Vietnam reach over 1.6 billion CAD[428] and over 2.6 billion CAD from Thailand[429]. These trade relations will likely only increase given the recent creation of the Canada – ASEAN Business Council (CABC) on August 31, 2012.

Conclusion: Canada's Concerns

The reality of future water scarcity in Southeast Asia should be a significant concern to Canada, especially with the likelihood of stronger future trade relations with the region. Water security in the region would not only allow for continual success among Southeast Asian economies but would also ease tensions between the riparian countries of the Mekong River. In order to promote the sustainability of the river, Canada can assist the governments of this region to explore improving the adaptive capacities of their agricultural sector such as land-use patterns, crop diversification, harvesting methods, crop resilience to climate change, etc. Infrastructural development projects such as new dyke systems can be designed to protect against coastal flooding, therefore protecting against sea-water encroachment. Participation in international water governance along with information sharing on the future dangers of climate change and dam-building can also build confidence among the LMRB countries that Canada has a permanent vested interest in guaranteeing that water is not only available to pursue economic needs but is also a human right. Canada should advocate for multilateral agreements that guarantee the long-term preservation of the Mekong as a viable water source.

(3) PAKISTAN AND THE INDUS RIVER BASIN

Introduction: Pakistan's Growing Importance for the Canadian Government

Over the coming decades, the impacts of climate change are expected to exacerbate the already fragile Pakistani state. Being strategically placed near the Middle-East and in possession of nuclear weapons, Pakistan, whose present state institutions are unlikely to deal with the future challenges of climate change, will remain an extremely high priority for the Canadian government. The focus of this section will be to illustrate how the effects of a warming climate will likely decrease

[428] Asia-Pacific Foundation of Canada, "Canada's Merchandise Trade with Vietnam," Assessed March 21, 2013 http://www.asiapacific.ca/statistics/trade/bilateral-trade-asia-product/canadas-merchandise-trade-vietnam.
[429] Asia-Pacific Foundation of Canada, "Canada's Merchandise Trade with Thailand," Assessed March 21, 2013 http://www.asiapacific.ca/statistics/trade/bilateral-trade-asia-product/canadas-merchandise-trade-thailand.

the future availability of water in the country and the implications this could have to the South Asia region, most notably between India and Pakistan.

By most accounts, Pakistan's investments in national infrastructure have been considerably below levels needed in order to maintain its distribution networks and power generation. For example, only 0.25 % of its GDP in recent years have been spent on water supply and sanitation while a 2009 poll indicated that 40 % of its population was disconnected from the country's electrical grid.[430] Ethnic and regional tensions that run deep through Pakistani society will likely worsen as resource scarcity quickly accelerates through the effect of climate change. The city of Karachi is already plagued by ethnic gang violence between the Sindhis, Pashtuns, and Mohajirs over differing political agendas.[431] Taking this into account, it is possible that climate driven resource scarcity could lead to the further deterioration of the rule of law within the city.

Pakistan's strategic importance to the Canadian government can best be illustrated through the volume of aid that the country has received. In 2010-2011, Pakistan was Canada's top recipient of humanitarian aid, receiving an estimated $91 million.[432] Adding to this, in 2009 the Canadian International Development Agency (CIDA) placed Pakistan on its list of twenty "countries of focus". [433] With Canadian forces having just exited Afghanistan in 2011, Pakistan also remains a high priority for the Canadian government as the former relationship between Pakistan and the Taliban has been previously described as both "close and complex."[434] Should the state infrastructure continue to remain weak, there is a very strong possibility that climate change will further weaken the state's borders and become a future refuge for extremist groups. According to Foreign Policy, since 2009 Pakistan has consistently ranked in the top 15 countries in terms of the likelihood of it becoming a failed state. Basing its ratings off of such measures as immigration movement, lack of political control over its country's affairs, and economic decline, Pakistan received a score of 101.9 in 2012 making it the 12th highest rated country on the list.[435] As such Canada has joined the international community in calling for greater efforts from Pakistan to confront extremist elements within its country.[436] Given the vulnerability and importance of Pakistan, coupled with the future effects of climate change, its importance to Canadian interests will likely further future collaboration.

Climate Change: The Observed and Projected Effects on Pakistan

Pakistan has already begun to experience drastic changes in its climate. Since the early 1900s the mean temperature along the coastal region of Pakistan has

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[430] Daniel Markey, "Pakistan," in *Climate Change and National Security: A Country-Level Analysis*, (Washington D.C.: Georgetown University Press, 2011), 89.
[431] Ibid.
[432] Canada International Development Agency. "Statistical Report on International Assistance 2010-2011." http://www.acdi-cida.gc.ca/acdi-cida/ACDI-CIDA.nsf/eng/ANN-321112057-KZN.
[433] Peter Jones, "Canada-Pakistan Relations: Where to Next?" *Asia Pacific Agenda of Canada*, (9): 2.
[434] Ibid.
[435] http://www.foreignpolicy.com/failed_states_index_2012_interactive
[436] Jones, 4.

reportedly increased between 0.6-1°C.[437] Increased temperatures within the region have also made the presence of extreme heat waves more extensive and frequent. In 2011 during these heat wave incidents, maximum temperatures were above normal by 6-7°C. On May 21st the city of Karachi experienced a high of 46°C, the hottest day in the city in the past 30 years.[438] Precipitation rates during the 2011 monsoon rainfall season (July-September) were also dramatically altered due to the effect of global warming. Overall, rainfall was 172% above the national average in 2011 and was ranked the fifth heaviest rainfall season that Pakistan had experienced in the past 52 years. The heavy rainfall over the Sindh province, a result of mid-tropospheric cyclones that formed over the north-eastern Arabian Sea, led to devastating floods which affected millions, destroyed agricultural crops and claimed 434 lives.[439]

Looking ahead, there is a very strong probability that Pakistan's climate will continue to drastically change should mitigation policies be overlooked. Warming in South Asia is expected to be above the global average of approximately 3°C for the 21st century.[440] As a result, the frequency of climatic extremes is also projected to increase during the next century. Between 1990 and 2008, 50% of South Asia's population was affected by natural disasters that resulted in $45 billion in damages. In all likelihood, heat waves and intense precipitation events in both Pakistan and South Asia, along with increased inter-annual variability of daily precipitation in the Asian summer monsoon, are projected to become more frequent in the coming years.[441] Furthermore, other estimates indicate that reductions of winter rainfall are anticipated to be slightly less than 10% in Pakistan by 2030.[442]

Pakistan's Emerging Water Crisis

Arguably, the most significant effect that climate change will have on the Pakistani state will be the future availability of water. Anatol Lieven, a South Asian scholar, warns that "water shortages [will] present the greatest future threat to the viability of Pakistan as a state and society."[443] Looking at the data, it is easy to conclude that the current water situation in the country is extremely worrisome. Since the early 1950s water availability has fallen from approximately 5,000 m^3 per capita to less than 1,500 m^3 per capita. At this rate, Pakistan is set to become `water

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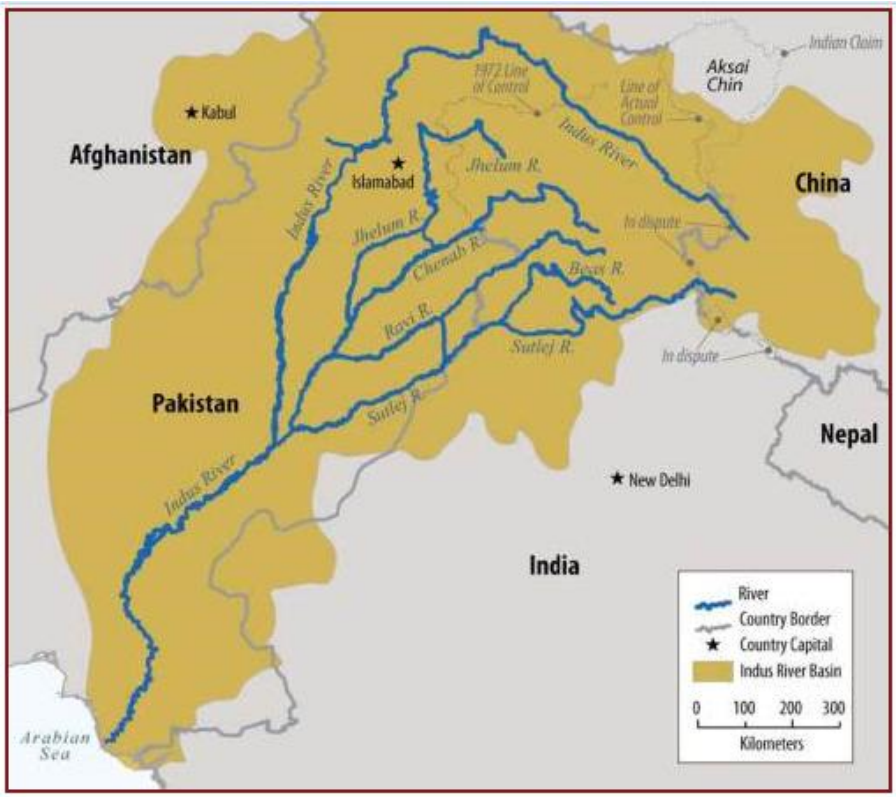
[437] Mannava V.K. Sivakumar and Robert Stefanski, "Climate Change in South Asia," Springer, in Rattan Lal et. al., eds., *Climate Change and Food Security in South Asia* (Heidelberg: Springer, 2011): 17.
[438] A.K. Srivastava, M. Rajeeven, and L. Zubair. 2012: South Asia [in "State of the Climate in 2011"]. *Bulletin of the American Meteorological Society*, 93 (7), S208.
[439] Ibid, S210.
[440]Sivakumar, 20.
[441] Ibid, 24.
[442] Janice Bathols, Ian McAdams, Benjamin J. Preston, and Ramasamy Suppiah, "Climate Change in the Asia/Pacific Regions."CSRIO (2006): 23.
[443] Robert M. Hathaway, "Introduction", in Michael Kugelman and Robert M. Hathaway eds., *Running Empty: Pakistan's Water Crisis* (Washington D.C.: Woodrow Wilson International Center for Scholars 2009): 5.

scarce`[444] by 2035, although some estimates project this could happen by as early as 2020.[445]

Data that projects the future supply and demand of water needs in the coming years also displays a precarious situation. Using a constant growth of 1.5% per annum, by 2025 Pakistan's population is expected to increase to 209 million. Pakistan would ultimately have to increase its water availability by 23% in order to meet the population's demand. Furthermore, the demand of water to meet net crops is projected to rise from 101.7 to 125.3 million acre feet, or a 19% increase, to meet the water demand for agriculture.[446] Despite these estimates, numerous studies have projected that while Pakistan's water availability will be 236 billion m^3 in 2025, its total water demand will be approximately 338 billion m^3 – a gap of 102 billion m^3.[447]

Climate change will not only pose a threat to the future water demands of Pakistan's population, but it will have several detrimental impacts on the state's economy. For example, over 90% of Pakistan's current water supply is allocated for agricultural use, leaving only 10% dedicated to drinking water. Being a semi-arid country, the agriculture industry contributes approximately 21% to the country's GDP.[448] Therefore, any interruption in future water supply would have devastating impacts on the Pakistani economy. Furthermore, while Pakistan can currently produce around 11,500 megawatts (MW) of electricity per day current estimates indicate the country's demand is 20,000 MW per day. Lastly, based on the fact that 34% of



[444] Water Scarcity is present when the water supply falls below 1,000 cubic meters per capita
[445] Ibid, 5.
[446] Ahmad, Shahid. "Water Insecurity: A Threat for Pakistan and India." The Atlantic Council for the United States (2012): 4.
[447] Hathaway, 24.
[448] Chandio, Khalid, "Water Security: Pakistan and Regional Perspective." *Islamabad Policy Research Institute* 12.1 (2012): 134.

its total electrical generation is produced by hydro sources, there is a safe assumption that the share of hydropower to total generation is likely to increase in the future. Under a developed scenario where there was a decrease in total precipitation by 1% across the region, it is estimated that there would also be a decrease of 1.5% in hydropower generation.[449] Therefore, any future disturbances in rainfall patterns could leave millions of Pakistanis without power.

Indus River Basin: A Future Source of Conflict?

The Indus River is the longest and arguably the most important body of water in Pakistan. The total length of the river is 3,200km, passing mainly through the borders of Pakistan, India, China, and Afghanistan. It produces an estimated 286.93 billion m^3 of available water resources annually. Despite this, the basin's current population of 215.8 million means that the annual per capita water availability is a mere 1,329 m^3 for the region.[450] A careful assessment of the country-wide annual water usage of the river indicates that Pakistan accounts for the 60% of the total water use, followed by India with 38%. Finally, while nearly 87% of the Indus river population has access to the improved drinking water sources, a closer look at the remaining 13 per cent indicates that nearly 28 million people in the basin do not currently have access to the rivers water source.[451]

In order to address the fact that the source rivers of the Indus basin are located in India and could potentially cut off Pakistan's water supply and create massive droughts and famines, the Indus Water Treaty (IWT) was signed between the two countries in 1960. With regards to river allocation, the treaty allocated three western rivers (the Indus, Jhelum, and Chenab) to Pakistan, with some water being allocated to India, while India was given exclusive rights to the eastern rivers (Ravi, Sutlej, and Beas).[452] As such, the IWT ultimately prohibits India from building dams for the purposes of water storage on the Indus, Chenab, and Jhelum rivers. Furthermore, India must provide Pakistan with any technical details of future water projects it wants to develop on the rivers before construction begins.[453] In general, the essence of the IWT is to share the water resources fairly between the two countries as the main source of the Indus basin is located and could create massive droughts and famine if India were to cut off its flow.

While the IWT has never been revoked in its fifty years of operation, there are well grounded fears that the rising demand of water will threaten the terms of the treaty because it inadequately solves the core issue of sharing water resources during seasonal dry periods (October to March), nor does it elaborate on trans-boundary groundwater extraction.[454] Moreover, climate change will have dramatic effects on

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[449] Ahsan Uddin and M. Monirul Quader Mirza, "Global Warming, Changes in Hydrological Cycle and Availability of Water in South Asia": 229.

[450] Mukand Babel and Shahriar Wahid. "Fresh Water Under Threat: South Asia." United Nations Environment Programme (2008): 14.

[451] Ibid, 16.

[452] Ahmad, 1.

[453] Chandio, 136.

[454] Ahmad, 3.

the amount of water that the river is able to supply. For example, the rapid thinning of the Himalayas, coupled with high intensity precipitation, will likely aggravate river flooding. When these glaciers have finally melted, river flows will decrease dramatically and lead to future issues of flooding and poor drainage within the next 50 years.[455] These projected effects led a 2009 CIA report to conclude that "the likelihood of conflict between India and Pakistan over shared river resources is expected to increase."[456]

Table 1: Renewable Water Resources and Per Capita Water Availability in the Indus Basin

Indus Basin	Total Renewable Water Resources MAF (km^3)	Per Capita Water Availability (m^3/person)			
		1990	2000	2025	2050
Indus-India	78.6 (97.0)	2,487	2,109	1,590	1,132
Indus-Pakistan	154 (190.0)	1,713	1,332	761	545

Source: IUCN, 2011. Indus Water Treaty and Managing Apportioned Rivers for the Benefit of Basin States—Policy Issues and Options. IUCN Pakistan, Karachi, p. 8.

Already, there have been several issues that have begun to arise over the allocation of the river's water supply. Pakistan has routinely criticized the Indian government of suppressing the flow of the river downstream to its country and many military officials, in response to the 2008 Mumbai terrorist attacks, have suggested water as being a 'latent cause' in the ongoing conflict in Kashmir. More recently, the Indian government has been accused of breaking the IWT clauses by planning to build 12 hydropower projects on the Kabul River.[457] The ongoing water crisis is arguably linked to the tense relationship between the Pakistani and Indian government; therefore, cooperation and normality in relations will be crucial for future peace in the region. Regional cooperation between India and Pakistan will not only enable better environmental management, but it will better facilitate inter-state sharing of the river's major benefits, such as increased irrigation for agriculture and hydropower production.

(4) WATER INSECURITY AND THE GANGES-BRAHMAPUTRA-MEGHNA(GBM) RIVER BASIN

Introduction

This section will discuss the effects of climate change on the Ganges-Brahmaputra-Meghna (GBM) River System and the countries (India, Bangladesh, Nepal, and Bhutan) that are affected by these bodies of water. Specifically, this section will look at the impact of water security, with reference both to water scarcity and instances of flooding. This area of Asia is especially vulnerable to water insecurity due to weak state capacity and geographic factors. Following an

[455] Hathaway, 7.
[456] Chandio, 135.
[457] Hathaway, 7.

examination of the climatology of the region, the foreign policy context will be taken into account with reference to Canada's position with each of the countries involved. Finally, this section will look at the effects of climate change on the areas in question.

Canadian Viewpoint – Why is it important?

As a developed country actively participating in international agreements, Canada plays a crucial role in addressing some of the needs of these countries. From a security standpoint, Canada must maintain strong relationships with a country such as India, which is projected to develop its economy at an exponential rate in the coming decades. As it stands, Canada and India have several important diplomatic relations, such as the Canada-India Free Trade Agreement.[458] Being the world's largest democracy, India is of great importance to Canada. The relationship is projected to strengthen in the future, given a 23.4% increase in bilateral trade between 2010 and 2011.[459] Bangladesh, the most affected of the countries by water insecurity, also has important ties to Canada. Next to India, Bangladesh is the largest source of Canadian merchandise imports from South Asia.[460] Therefore on the basis of economic and trade relations alone, it is extremely important that Canadian foreign policy take into consideration the effects of climate change in area. The heavy dependence on water for agriculture, and the great vulnerability to climate change in sectors including industry means that water scarcity and insecurity have a significant impact on these countries' economies. As a country affected by bilateral relations, the economies of these countries have the ability to compromise Canada's economic relations with them. Canada's role in the following situation is difficult to see in the direct sense. However, Canada is capable of acting as a mediator in various trans-boundary issues between India, Bangladesh, Nepal, and Bhutan.

Climatology of the Ganges-Brahmaputra-Meghna River System

The GBM River System contains a complex of 230 rivers, including 57 trans-boundary rivers.[461] It contains the three main rivers Ganges, Brahmaputra, and Meghna, all of which originate from the Tibetan Plateau. The Brahmaputra begins in China and flows east, followed by a gorge resulting from a change in direction towards the south-west direction, and subsequently flowing through northeastern India, and finally Bangladesh.[462] The Brahmaputra River Valley extends approximately 2,900 km in length from the Himalayas to the Indian Ocean, and has

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[458] Government of Canada, "Canada-India Free Trade Agreement Negotiations," Department of Foreign Affairs and Trade (DFAIT) Accessed March 18, 2013. http://www.international.gc.ca/trade-agreements-accords-commerciaux/agr-acc/india-inde/index.aspx?lang=eng&view=d

[459] Ibid.

[460] Ibid.

[461] N.J. Ericksen, M. Monirul Qader Mirza, and R.A. Warrick, "The Impact of Climate Change on Floods of the Ganges, Brahmaputra, and Megna Rivers in Bangladesh," *Climate Change* 57 (2003): 287.

[462] Kishor Uprety and Salman M. A. Salman, "Legal Aspects of Sharing and Management of Transboundary Waters in South Asia: Preventing Conflicts and Promoting Cooperation," *Hydrological Sciences Journal* 5(4), (June 2011): 649.

a total basin area of 0.935 x 10^6 km^2.[463] Secondly, the Ganges River begins in China and Nepal, flowing southeast through India, and finally flowing into Bangladesh.[464] In its journey through India, the Ganges drains approximately 30% of the country. The two main rivers of Ganges and Brahmaputra meet in Bangladesh and subsequently become the Padma River. Finally, the Padma meets the Meghna River in Chandpur, Bangladesh, and eventually flows into the Bay of Bengal.[465]

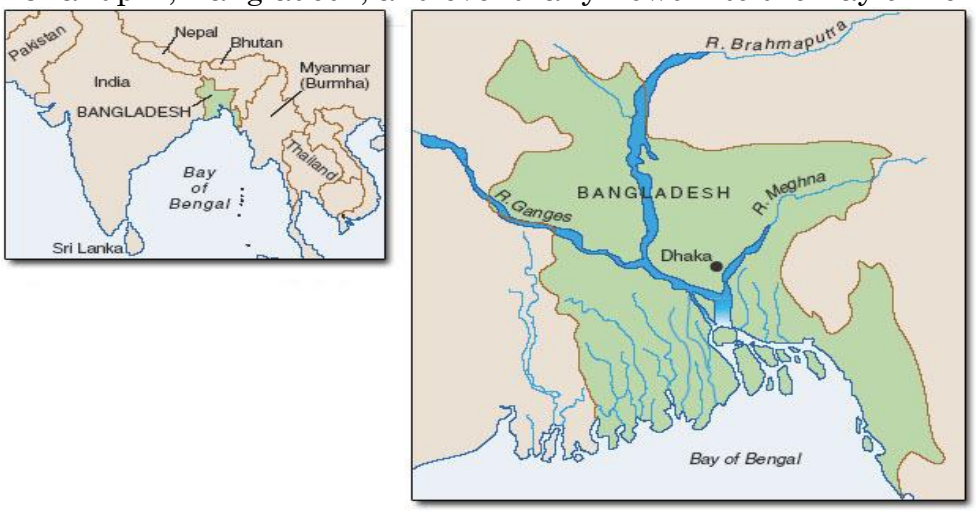

Figure 1: The Ganges-Brahmaputra-Meghna River Basin

Source: The Open University, 2007. <http://school.demo.moodle.net/pluginfile.php/2402/mod_imscp/content/2/Items/x_sdk125_1_thumbnail_id400049014020.html>

The River System is especially vulnerable to the effects of climate change as it experiences a regular change of seasons, each with varying levels of precipitation. A recent study on the implications of climate change on the area estimated a combined mean annual precipitation of 22,045 mm in the River System.[466] The instance of precipitation, combined with all four countries' heavy dependence on agriculture makes both flooding and water scarcity a contentious issue in the field of climate change and security. Studies have shown that the flood damage in this area of Asia has been increasing over the course of the century. By the 1980s, annual flood damage had increased forty times above the rate of the 1950s.[467] The increasing demand for water met with the decrease in supply of water results in water scarcity in various areas. It has been predicted that by 2030, India's river basins will face a severe water deficit. This is premised on the fact that by 2030 demand for water will grow to 1.3 trillion m^3, and supply will in turn only be 740 billion m^3.[468] In India alone, water scarcity will affect such areas as Rajasthan, Uttar Pradesh, Bihar, and

[463] Maoshan Li et al., "Climate Change Features Along the Brahmaputra Valley in the Past 26 Years and Possiblee Causes," *Climate Change* 106 (2011): 650.
[464] Uprety and Salman, "Legal Aspects of Sharing and Management of Transboundary Waters in South Asia," 649.
[465] Ibid, 649.
[466] N.J. Ericksen et al, "The Impact of Climate Change on Floods of the Ganges, Brahmaputra, and Megna Rivers in Bangladesh," 289.
[467] Ibid, 55.
[468] 2030 Water Resources Group, *Charting Our Water Future: Economic Frameworks to Inform Decision Making* (London: McKinsey & Company, 2009), 10.

the southern states of Andhra Pradesh, Karntaka, and Tamil Nadu.[469] Furthermore, the melting of the Himalayan glaciers leads to the unique instance of drought followed by flood in certain regions. This is because melting glaciers cause "abnormally low flows in the early summer and winter months, and abnormally high flows during the monsoons."[470]

Effects of Climate Change on the GBM River Basin

The effects of this climate change on the GBM River Basin and the riparian countries are numerous. However, due to space limitations, this section will focus on what is believed to be two of the most contentious international relations issues in the area. The first of these is the river management systems that are both in place and that have been proposed. This section will explore past successes, current failures, and give recommendations for future prosperity in the field of river management. Secondly, this section will also look at the impact of water insecurity on human security, as shown in the cases of migration.

(a) Transboundary Water Management Issues

River Management is a crucial area in climate change and security in India, Bangladesh, Nepal and Bhutan. Given the presence of some fifty-seven trans-boundary rivers, it is important for these countries to maintain diplomatic consensuses regarding the management of these rivers. Some scholars believe that the proper management of these rivers can help with the economic growth of each country as well.[471] Ultimately, a more efficiently functioning economy can assist in strengthening overall state capacity, which in turn will allow for better adaptation and mitigation to anthropogenic climate change in the BGM riparian countries. More importantly, scholars such as Asit K. Biswas contend that proper management of river basins prevent the extreme prediction of "water wars" over shared sources of water in the region.[472]

In the past, a positive example of effective river management has existed between India and Bhutan. The latter's small geographic size as well as low capacity caused it to seek cooperation over conflict in the instance of water security. The outcome was the construction of several hydroelectric power projects that benefited both parties. [473] The success of their first collaboration over the Chuka power plant resulted in additional collaborations such as the Kuri Chu plant.[474] In contrast, the collaboration between India, Nepal, and Bangladesh has yielded dismal results with respect to river management.[475] There have been a multitude of agreements between these countries, yet none have shown promise for prosperous water sharing in the

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[469] TV Paul, "*India," Climate Change and National Security: A Country Level Analysis* (Washington D.C.: Georgetown University Press, 2011): 75.
[470] Ibid.
[471] Asit K. Biswas, "Cooperation or Conflict in Transboundary Water Management: Case Study of South Asia," *Hydrological Sciences Journal* 56:4 (July 2011): 663.
[472] Ibid, 663.
[473] Ibid, 667.
[474] Ibid.
[475] Ibid, 668.

future. For example, the Farrakka Barrage resulted in increased tension between India and Bangladesh in the 1980s.[476] Bangladesh claimed the barrage was diverting water away from its own territory, thereby creating damage to its water table and compromising its agricultural yield.[477] The Farrakka Barrage example is just one of many unsuccessful projects carried out that have not considered other riparians involved in the trans-boundary waterway. The example of the Chuka and Kuri Chu plants serve as a template for future cooperation between other countries in the GBM Basin.

(b) Migration

The second issue pertaining to climate change and water insecurity in South Asia is migration. Here the human security effect of climate change is evident as some statistics as recent as 2009 show 15-20 million people have migrated from Bangladesh to India. [478] The claims of migration are sensitive topic for the country of Bangladesh, where the heart of the GBM River Delta is located, and thus is subject to the most flooding caused by climate change. In the last two decades. Bangladesh has seen three extreme floods, one of which affected 70% of its area in 1998. The predicted temperature increase of 2°C will result in a 23-29% increase in the flooded area of Bangladesh during the monsoon.[479] In connection to the previous discussion on ineffective water management, India's water diversion schemes have been blamed for the environmental damage that has caused mass rural-urban migration within Bangladesh.[480] Water scarcity in rural areas causes migration because those populations are especially dependent on agriculture, which is in turn dependent on the availability of water. There are a multitude of issues that arise from this kind of mass movement of peoples, whether it is intra- or interstate. As such, mitigation policies must be set in place by these regions to accommodate for 'climate refugees', as they are called.

Overall, the politics between Bangladesh and India have been strained as a result of contention over issues of water scarcity. These issues of trans-boundary water management and migration will have potential indirect effects on Canada given its relationship with each of the countries involved.

(5) POLICY RECOMMENDATIONS

1. **Investment** – If countries are to adequately mitigate the many challenges of water availability within the coming decades, states will need to begin making serious commitments towards both developing and financing state

[476] Paul, "India," 80.
[477] Uprety and Salman, "Legal Aspects of Sharing and Management of Transboundary Waters in South Asia," 650.
[478] Riaz, "Bangladesh," 108; Paul, "India," 79.
[479] Sanjay Chaturvedi and Timothy Doyle, "Geopolitics of Fear and the Emergence of 'Climate Refugees': Imaginative Geographies of Climate Change and Displacements in Bangladesh," *Journal of the Indian Ocean Region* 6: 2 (December 2010): 211.
[480] Riaz, "Bangladesh," 106.

infrastructure and development projects which will help meet the growing demand of water.

2. **State Cooperation** – Open communication and a clear understanding of each country's needs should be strongly considered amongst the South Asia region in order to ensure each state has the resources it needs to meet their future populations. If these countries, most notably India, China, and Pakistan, can engage in a cooperative manner then there is a strong possibility that each state will be able to enjoy the benefits that the Tibetan Plateau can provide in the coming years.
3. **Conservation** – There should also be a paradigm shift in the way that water is used within each region. If agricultural investments are made in improving the technology farmers can easily begin adopting techniques that can lower the amount of water used on crops. Citizens can also seek alternative methods in water resources such as rainwater capture. Likewise, countries within this region can also diminish water waste by improving the efficiency of hydro-electric dams, where water is often inadequately stored. These adaptive policies to the effects of climate change will be a key process in enduring the future availability of water.
4. **Canada as an International Mediator** – If Canada wishes to emphasize its capabilities as a significant player in the Pacific region, it should emphasize mediating potential water disputes in Asia, specifically within the water systems of the Tibetan Plateau. As tensions will inevitably rise, especially between Pakistan and India over the dwindling water supply, Canada will need to use its influence to help foster both collaboration and stability within the region. Furthermore, Canada should push for states such as China, to engage in international cooperation to ensure efficient basin management in areas where these problems transcend national boundaries.

MIDDLE EAST & NORTH AFRICA

Climate Change and Water Security in Middle East and North Africa

In contemporary international politics, insecurity is defined in terms of direct military threats to national interests or security posed largely by "rising or declining powers; security dilemmas between rival states; physical and virtual terrorist attacks; and denial of access to any of the world's common spaces- most notably water resources and air."[481] With the United States emerging from a post-9/11 period of extensive securitization, Werz and Hoffman argue that, "The global community must de-emphasize traditional notions of hard security more suited to the Cold War and focus on more appropriate concepts such as human security, livelihood protection, and sustainable development."[482] Consequently, over the past twenty years there has been a paradigm shift from a state centric international system focused on national gains to a "growing recognition that global problems, crises and conflicts were resulting from a more complex and intertwined set of causes" including that of climate change. Yet, while there are clear and imminent impacts for states in the realm of high politics, particularly in the energy and agricultural sectors, the most pressing issues concern the politics and practice of development, institution and capacity building in low-income and climate vulnerable states.

Table 1. Water Availability in the MENA region

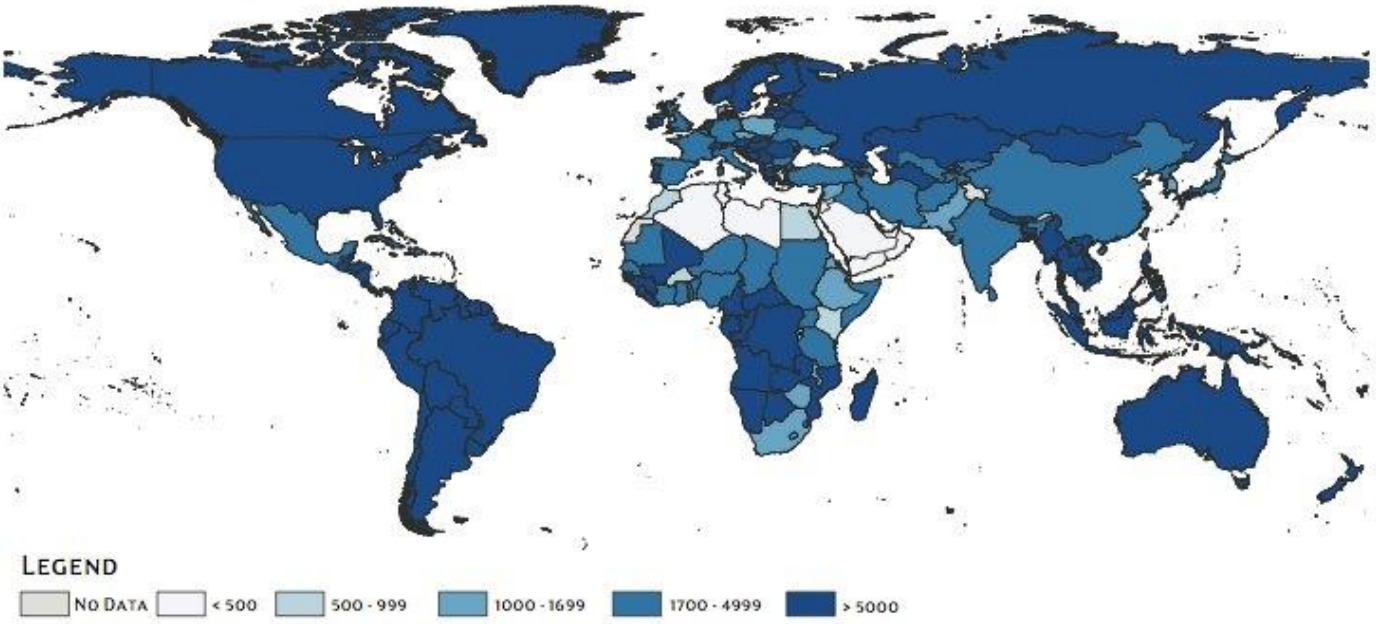
Ranking	Country	Total internal renewable water resources (km^3/year)	Groundwater: produced internally (km^3/year)	Surface water: produced internally (km^3/year)	**Water resources: total renewable per capita (m^3/capita year)**
108	Iraq	35.20	1.20	34.00	**3 287**
131	Iran	128.50	49.30	97.30	**1 955**
141	Syria	7.00	4.20	4.80	**1 622**
149	Lebanon	128.50	49.30	97.30	**1 261**
155	Morocco	29.00	10.00	22.00	**971**
156	Egypt	1.80	1.30	0.50	**859**
162	Tunisia	4.15	1.45	3.10	**482**
163	Algeria	13.90	1.70	13.20	**478**
164	Djibouti	0.30	0.02	0.30	**475**
165	Oman	0.99	0.96	0.93	**388**
167	Israel	0.75	0.50	0.25	**276**
168	Yemen	4.10	1.50	4.00	**223**
169	Bahrain	0.004	0.00	0.004	**181**
170	Jordan	0.68	0.50	0.40	**179**
172	Malta	0.05	0.05	0.00	**129**
173	Saudi Arabia	2.40	2.20	2.20	**118**
174	Libya	0.60	0.50	0.20	**113**
176	Qatar	0.05	0.05	0.001	**94**
178	United Arab Emirates	0.15	0.12	0.15	**58**
179	Palestine (Gaza)	0.05	0.05	0.00	**52**
180	Kuwait	0.00	0.00	0.00	**10**

Source: World Water Development Report 2003. (The country selection is based on the World Bank's definition of the MENA region). N.B. The water dependency ration refers to surface water. Many of the countries that have zero water dependency ratio do in fact share transboundary groundwater aquifers with other countries.

[481] David Michel et. al, *Water Challenges and Cooperative Response in the Middle East and North Africa*(Washington: Brooking Institution, 2012), 1.
[482] Ibid.

Figure 1: Total Actual Renewable Water Resources per Inhabitant (m^3/year)
Actual renewable surface water and groundwater resources per inhabitant (in 2005)

Source of data: FAO-AQUASTAT, 2008.



The impacts of anthropogenic climate change on climate, biodiversity and natural resources "have exacerbated the perils of the human condition;" however, of utmost concern and interest to this section is the integrated relationship between development, human security, and water scarcity.[483] Societies across the Middle East and North Africa (MENA) have long sought balance between the competing water demands of households, industry and agriculture.[484] While the impacts on industry are extensive, more importantly the impacts on human security within the region have far reaching impacts for international security. As the MENA region is home to more than "7 percent of the world's population," and is expected to grow by approximately 57% over the next three decades, the implications with respect to state failure, interstate conflict and migration are vast.[485] This insecurity is amplified by the fact that the "region is endowed with less than 1.5% of the world's renewable freshwater supply."[486] As such, due to limited resources in a largely arid- to semi-arid region, "careful management of water resources has been an absolute necessity in this region where annual renewable water supplies average about 623.8 billion cubic meters (BCM) compared to Africa's 3,950 BCM, Asia's 12,009 BCM and the world

[483] Michel et. al, 3.
[484] Hakan Tropp and Anders Jagerskog. 2006. "Water Scarcity Challenges in the Middle East and North Africa," *Stockholm International Water Institute.* (Stockholm, Sweden), 3.
[485] Caitlin Werrell and Francesco Femena. 2013. "The Arab Spring and Climate Change: A Climate and Security Correlation Series," *Center for American Progress.* (Stimson: New York, USA), 3.
[486] Ibid.

total of 43,764 BCM."[487] Water scarcity has typically been defined as an "annual water availability of less than 1,000 m^3 per capita" at which point this scarcity constitutes "a significant constraint on socio-economic development."[488] Based on regional analysis, the MENA countries "possess annual renewable water resources of 1, 274 m^3 per capita, making it the most water stressed region in the world.[489] With a projected increase in temperature and frequency of droughts, this condition will only become more severe.

This section of the report examines the implications climate change will have on the three key river basins in the MENA region: the Euphrates-Tigris, Jordan and Nile basins. The findings reveal that each faces distinct political, economic and social challenges. In discussing what the challenges have been and will be for each of these basins as a result of climate change induced water insecurity, it will become evident that within the next four decades, the levels and means of regional cooperation will have to become more coherent and focused on issues of international water management. This section illustrates both the potential for conflict and for cooperation in the region over the issue of water security. A shift in public policy regarding water usage will have to take place in order to bring about the latter scenario, which is an approach that may feature Canadian involvement. The section will conclude with a brief outline of various adaptation approaches employed in several MENA countries and how these plans can raise the potential for international conflict, along with an outline of current Canadian regional involvement and the potential role it could play in the drier years facing the people of the Middle East and North Africa.

(1) THE EUPHRATES-TIGRIS RIVER BASIN: CLIMATE CHANGE PROJECTIONS

The majority of the watershed from the Euphrates-Tigris is formed by the merger of two streams (the Murat and Karasu) that flow southeast from Turkey towards Syria at Karakamis point. The Euphrates-Tigris continues through Syria on this route and is joined by two additional streams (the Khabur and Balikh), both of which have origins in Turkey.[490] These streams are primarily fed by snowmelt originating from the Turkish eastern highlands, between Lake Van and the Black Sea.[491] A conservative estimate indicates that approximately 88% of the water in the Euphrates River is derived from Turkey alone. Nearly 60% of the Tigris River flow

[487] Michel et al., 1.
[488] Ibid.
[489] David Michel et. al., "Water Challenges and Cooperative Response in the Middle East and North Africa" (Washington: Brookings institution, 2012), 1.
[490] M. Ozdogan, "Climate Change Impacts on Snow Water Availability in the Euphrates-Tigris Basin," *Hydrology and Earth System Sciences* (2011): 2789.
[491] Akanda Ali, Sara Freema, and Maria Placht, "The Tigris-Euphrates River Basin: Mediating a Path Towards Regional Water Stability," *al Nakhlah: Online Journal on South West Asia and Islamic Civilization* (Spring 2007): 1.

originates below Baghdad, although it is still linked to seasonal variations in Turkish precipitation.[492]

The Euphrates-Tigris River Basin has a north-south precipitation gradient characterized by humid highlands in the north and arid Mesopotamian lowlands in the south. Precipitation patterns between these two regions are highly differentiated, with the highlands receiving over 1,200mm/year and the south receiving a mere 100mm.[493] In the spring, large volumes of melt water typically dominate discharge patterns of the Euphrates-Tigris. This melt water, originating from the mountains of Turkey, Iran and Kurdistan, causes the Euphrates-Tigris to flood between March and May, coinciding with the beginning of the long, dry Iraqi summer. During the summer months, melt water from these sources may represent up to 100% of the discharge into the rivers of the Mesopotamian lowlands.[494] According to projected increases in global concentrations of greenhouse gases, climate change will fundamentally alter the magnitude of seasonal variations in the Middle East. This is expected to greatly impact mountainous ecosystems in the region, where seasonal snowpack is a key component of the hydrologic cycle. A decline in snow storage due to increased global temperatures could reduce snowmelt contributions to the Euphrates-Tigris river basin, thereby reducing power output in downstream generators and negatively affecting aquatic habitat, fish migration and wetland replenishment.[495] Unfortunately, there are still considerable uncertainties regarding the impacts of global warming on changes in the supply and demand of water. Increased

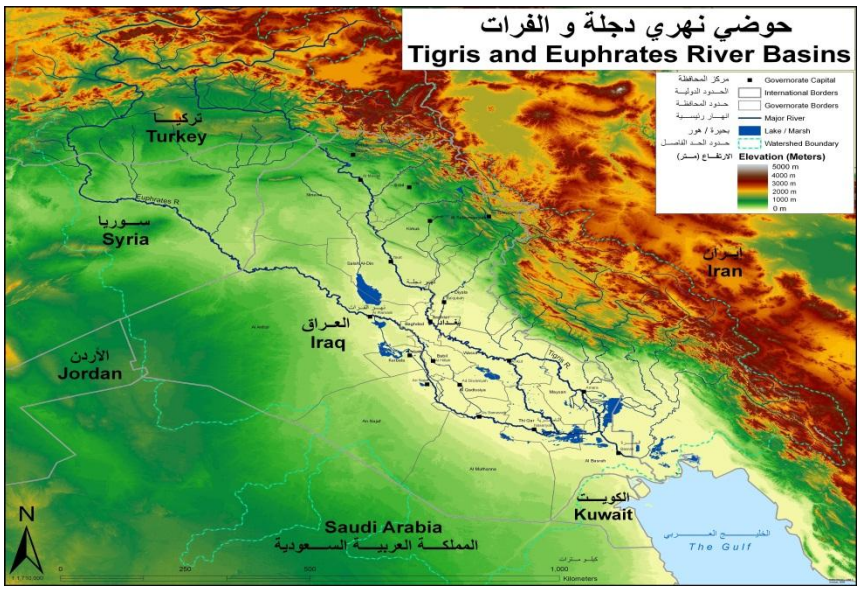


Figure 2: Tigris and Euphrates Basin
Source:
http://dspace.library.uvic.ca:8080/bitstream/handle/1828/2398/B_2.jpg?sequence=1

[492] Jon Martin Tronalen, "Climate Changes, Water Security and Possible Remedies for the Middle East," The United Nations World Water Assessment Programme (2009): 18.
[493] Benjamin F. Zaitchik, Jason Evans, and Ronald B. Smith, "MODIS-Derived Boundary Conditions for a Mesoscale Climate Mod," *Monthly Weather Review*, 133, no. 6 (2005): 1728.
[494] Carol Howe, Joel B. Smith, and Jim Henderson, *Climate Change and Water: International Perspectives on Mitigation and Adaptation*, (Denver: IWA Publishing, 2010), 34.
[495] M. Ozdogan, "Climate Change Impacts on Snow Water Availability in the Euphrates-Tigris Basin," *Hydrology and Earth System Sciences* (2011): 2789.

evapotranspiration, decreased precipitation, or combinations of both, are described as potential sources of runoff reductions in the future.[496]

A reduction in snowmelt contributions will have the greatest effect on water management programs conducted by Turkey, Syria and Iraq. Current programs focus heavily on capturing snow-generated runoff through a series of dams and releasing it for irrigation and other purposes in the warmer seasons.[497] As a result, all three nations have become incredibly dependent upon the continual replenishment of the Euphrates-Tigris. Climate change impacts are also expected to catalyze an increased reliance on groundwater pumping from underground reservoirs in the region. According to data collected by the Gravity Recovery and Climate Experiment (GRACE), the Euphrates-Tigris river basins currently have the second fastest rate of groundwater loss in the world, after India.[498]

Overall, climate change in the Euphrates-Tigris will have a significant impact on evaporative loss, water demand, agricultural output and hydroelectric energy planning. Due to these effects, water-related conflicts between the riparian countries are expected to increase. Approximately 90% of the Euphrates-Tigris water flow originates in Eastern Turkey, streaming south towards Syria and Iraq.[499] Consequently, Turkish water policy will effectively determine the level of water security provided to its riparian neighbours. Proceeding sections of this analysis will examine the effects of climate change on Turkey, Iraq and Syria in addition to providing a detailed outline of their individual hydro-political context.

The Republic of Turkey

The Republic of Turkey is situated in a semi-arid geographic region, possessing just one-fifth of the water per capita controlled by the water-rich nations of North America and Western Europe.[500] The term 'water-rich nation' in this case will be defined by a country possessing between 8-10m^3/capita/year. Turkey controls a mere 1586m^3/capita/year, with this figure expected to decrease to 1000m^3 by 2023.[501] Utilizing its 172 hydroelectric power plants, Turkey produces an average of 48,000 GWh/year of hydroelectric power.[502] Turkey's annual hydroelectric yield equates to approximately 24.5% of the country's total energy. With domestic energy consumption rising 5.7% per year due to rapid urbanization and industrialization, electricity consumption is expected to rise to 60.23 GWh/year by 2020.[503] Due to the fact that Turkey is neither an oil nor natural gas producer, the Turkish Government has asserted that hydroelectric power will provide the country with a clean and cheap

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[496] Jon Martin Tronalen, "Climate Changes, Water Security and Possible Remedies for the Middle East," The United Nations World Water Assessment Programme (2009): 19.
[497] M. Ozdogan, "Climate Change Impacts on Snow Water Availability in the Euphrates-Tigris Basin," *Hydrology and Earth System Sciences* (2011): 2790.
[498] Freshwater Stores Shrank in Tigris-Euphrates Basin, 2013.
[499] Ibid.
[500] Turkey's Policy on Water Issues, 2011.
[501] Republic of Turkey. "Turkey Water Report." (2009): 10.
[502] Ibid., 20.
[503] Turkey's Policy on Water Issues, 2011.

alternative energy source. Through a variety of storage systems and complex irrigation networks, Turkey is utilizing its water for sustainable socio-economic development, including over 17 million hectares of rain-fed agriculture.[504] This water is primarily derived from the Euphrates-Tigris River Basin, which provides Turkey with 31% of its total surface water runoff (193 billion m^3/year).[505] Water derived from the Euphrates-Tigris is used to support a variety of development efforts, including the Southeast Anatolia Project (GAP), Turkey's largest hydroelectric and irrigation development scheme. Overall, Turkey sees water as a potential source of cooperation rather than conflict among other riparian states.[506] It believes that economic development such as the GAP will benefit all neighbouring regions, and help foster a climate of peace between states in the Middle East.[507]Furthermore, Turkey asserts that the looming global water shortage can only be addressed through a holistic approach involving assistance from developed countries, regional and international organizations, and financial institutions.[508]

The Republic of Iraq

The Republic of Iraq obtains its water primarily through the Euphrates-Tigris River Basin. Approximately 50% of the water from the Tigris River and 90% from the Euphrates originates outside the country.[509] In order to adequately adapt to this situation, Iraq signed an official agreement with Syria in 1990 which granted Iraq 58% of the water Syria acquired from Turkey.[510] Regardless, the country is still experiencing chronic water deficiency. In May 2004, the Iraqi Minister of Water Resources asserted that Iraq has historically utilized almost thirty billion cubic meters of water each year[511]; currently, it uses barely one third of this amount.[512] Recent estimates of available water in Iraq are approximately 2400m^3/capita/year, slightly less than Turkey's figure of 2890m^3/capita/year.[513] Syria, on the other hand, is thought to currently possess just 791m^3/capita/year.[514] Due to climate change, Iraq's water availability is projected to decrease to1664m^3/capita/year by 2025.[515] Iraq's conventional water resources stem from surface water (70,370 MCM), ground-water use (513 MCM), and ground-water recharge (2000 MCM), while its non-conventional water resources are derived from desalinated water (7.4 MCM), in addition to waste-water and drainage reuse (1500 MCM). Total renewable and non-

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[504] Republic of Turkey. "Turkey Water Report." (2009): 11.
[505] Ibid., 8.
[506] Turkey's Policy in Water Issues, 2011.
[507] Ibid.
[508] Ibid.
[509] Frederick Michael Lorenz, "American University International Law Review," *Strategic Water for Iraq: The Need for Planning and Action* (2008): 276-277.
[510] Ibid., 277.
[511] Ibid.
[512] Ibid., 276-277.
[513] United Nations Inter-Agency Information and Analysis Unit. "Water in Iraq Fact Sheet." Last modified 2011.
[514] Ibid.
[515] United Nations Economic and Social Council, "Module Eight: Balancing Water Supply and Demand," Economic and Social Commission for Western Asia (2005): 7.

conventional resources equate to 73,877.4 MCM.[516] Meanwhile, projected water demand is estimated to reach 8000 MCM, 90,000 MCM, and 10,000 MCM for domestic, agricultural and industrial use respectively by 2025.[517] Increased water demand has the capacity to catalyze future water conflicts between the riparian states and their associated allies.[518]

According to Professor Tony Allen of the University of London, the Middle East effectively ran out of water in the 1970s when demand began to outpace supply.[519] This began when the Middle East and North African (MENA) economies became exposed to increasing water deficits. They turned to the grain producers of the United States Department of Agriculture (USDA) and the European Union (EU) who had been making water available in grain at prices around half their production cost.[520] As such, the shortage has since been made up by the acquisition of "virtual water" via imported goods.[521] Nations unable to acquire this virtual water through trade may eventually be forced to do so via other means. Although the threat of full-blown water-wars between Turkey, Syria and Iraq may not be imminent, water security will become an increasingly volatile issue over the next few decades.[522]

The Syrian Arab Republic[523]

Syria is a state with a population of 20.4 million people and a projected growth rate of 2% per year.[524] It has an area of 185,180km^2 with five separate agro-ecological zones depending on annual precipitation; the most arid and semi-arid of which are located in the North, South and East.[525] Like Iraq, Syria is also experiencing a severe water deficit. More than 60% of the country receives only 250mm of rainfall per year. Due to the fact that the potential evaporation rate in Syria is typically 1300mm per year in the West and even 3000mm per year in the Eastern and South Eastern parts of the country, water in Syria is becoming a scarce and invaluable commodity.[526] Turkey has agreed to provide Syria with at least 500m^3/s of the Euphrates water flow. Iraq receives 58% of this amount due to an arrangement with Syria, leaving the Syrian share of water from the Euphrates at 6623 MCM with an additional 1250 MCM provided by the Tigris.[527] These figures are expected to eventually decrease due to the effects of climate change. The Euphrates River flow alone may be reduced by

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[516] Ibid., 7.
[517] Ibid.
[518] Lorenz, 276-277.
[519] John A. Allan, and Tony Allen, *The Middle East Water Question: Hydropolitics and the Global Economy*, (New York: I.B. Tauris & Co Ltd, 2001), 5.
[520] Ibid., 194.
[521] Lorenz, 278.
[522] Ibid., 279.
[523] Due to space limitations, the implications of the current civil war in Syria on water security in the country have not been considered.
[524] Bertelsmann Stiftung, "Syria Country Report," *BTI 2012* (2012): 2.
[525] Khaldoon A. Mourad, and Ronny Berndtsson, "Air, Soil and Water Research," *Syrian Water Resources between the Present and the Future* (2011): 94.
[526] Ibid., 95.
[527] Mourad and Berndtsson, 96.

29%-73%, and the average temperature of the Middle East is estimated to increase by 2.5 degrees Celsius by 2050 (thereby increasing Syrian evaporation rates).[528]

Syrian water demands are predicted to increase in step with global warming. The majority of these demands are currently from Syria's agricultural sector. Agricultural water consumption was 15400 MCM in 2010, compared to just 648 MCM and 1258 MCM in the industrial and domestic sectors respectively. Due to the effects of global warming, these figures are projected to change to 12543 (agricultural), 1344 (industrial) and 18074 (domestic) by 2050.[529] Meanwhile, Syria's population is expected to rise to 39.6 million with a daily per capita water consumption of 125 liters. This will result in an annual domestic water demand of 1800 MCM by 2050.[530] It should also be noted that Syria is currently in the midst of a civil war, a fact that may significantly impact these projected figures.

Potential Areas of Conflict

Due to its increasing energy needs, Turkey has become heavily involved in water development efforts, primarily in Southern Anatolia and the Euphrates-Tigris Basin. These efforts, though highly beneficial for Turkey, are sparking resentment from Syria and Iraq and are being justified on the grounds that Turkey is experiencing an energy deficit.[531] This development is being facilitated through the construction of the Southeast Anatolia Development Project (GAP), a major hydroelectric and irrigation development scheme.[532] The GAP project covers nine Turkish provinces, equating to an area of 75,000km^2 and including approximately 10% of Turkey's population.[533] This project is being utilized to develop water resources in the region to alleviate socio-economic poverty and promote balanced regional development.[534] It is designed to expand Turkey's irrigated area in the region from 4.16mha to 5.86mha via the construction of 22 storage dams and 19 hydro-power plants.[535]

Initial conflict between Syria and Turkey over this issue began when the late President of Syria, Hafez al-Assad, recognized that GAP would cost him up to 40% of the Euphrates water flow, negatively affecting his plans to irrigate the Euphrates valley, in turn threatening food security, and compromising the already minimal Syrian hydroelectric yield.[536] Political tensions with Iraq, on the other hand, stem from their minimal appropriation of approximately 13% of the Euphrates water flow. As such, Iraq fears that Turkey's development scheme will reduce these flows to a

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[528] Ibid.
[529] Ibid., 97.
[530] Ibid.
[531] Patrick MacQuarrie, *Water Security in the Middle East: Growing Conflict Over Development in the Euphrates-Tigris Basin*, Unpublished MA Thesis, Trinity College, Dublin, 2004: 9.
[532] Ibid., 11.
[533] Aysegul Kibaroglu, "Development of Irrigation Systems in The Southeastern Anatolia Project (GAP) Region" (2009): 1.
[534] Ibid., 2.
[535] Ibid.
[536] MacQuarie 34.

level capable of rendering Iraq's irrigation plans useless.[537] The Southeast Anatolia Project has also elicited resistance from social and environmental NGOs who have been targeting international donors and contractors.[538]

The basis of disagreement between Turkey and its riparian neighbours centers on different interpretations of international law. Turkey maintains the transboundary nature of the basin, and has proposed regional cooperation that includes unified data collection and management, agricultural joint ventures, the construction of canals to supplement the Euphrates with water from the Tigris, and a Peace Water Pipeline designed to supply water to Syria, Jordan, Iraq and Saudi Arabia.[539] The latter of which would supply Turkey's regional neighbours with water from its national rivers, notably the Seyhan and Ceyhan.[540]

Syria and Iraq, on the other hand, consider the Euphrates-Tigris Basin to be international waters, and believe that their equal rights to it are not being adequately protected.[541] Iraq in particular has been profoundly affected by Turkey's water development efforts. For example, Iraq used to receive 20.9 km^3/year of water from the Tigris. This figure is expected to decrease to 9.7km^3/year once the Ilisu Dam is constructed, thereby reducing Iraq's water flow from the Tigris River by a 47% and causing 696 10^3 hectares of agricultural land to be abandoned.[542] The Ilisu Dam is expected to be constructed in approximately 7-8 years.[543]

Due to this disagreement, Turkey's water-poor riparian neighbours have transformed the GAP project from a traditional low-politics issue into a high-politics issue. The importance of water has become elevated and subsequently linked to national security, with the goal of widening or narrowing the gap between the regional hydro-hegemon and non-hegemons.[544] Nevertheless, despite the absence of a Euphrates-Tigris basin treaty, an unofficial basin regime in the form of predictable state behaviour (near-wars followed by near-or placeholder agreements) has been established[545]. This unofficial basin regime is characterized by the de facto acceptance of the GAP on the part of Turkey's downstream neighbours.[546] Currently, there exists an expectation of cooperation based on the operational record of Turkey where issues have been resolved via negotiation as opposed to violence.[547]

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[537] Ibid., 42.
[538] Jeroen Warner, "The struggle over Turkey's Ilısu Dam: domestic and international security linkages," *International Environmental Agreements: Politics, Law and Economics* 12, no. 3 (2012): 231.
[539] Vahid Alavian, "Shared Waters: Catalyst for Cooperation," *Journal of Contemporary Water Research and Education* 115, no. 1 (2011): 8.
[540] Mithat Rende, "Policies and Strategic Options for Water Management in the Islamic Countries: Proceedings of the Symposium organized by the Regional Centre on Urban Water Management (RCUWM-Tehran),"International Hydrological Programme, no. 73 (2003): 34.
[541] Alavian, 8.
[542] Nadhir Abbas Al-Ansari, and Sven Knutsson, "Toward prudent management of water resources in Iraq," *Journal of Advanced Science and Engineering Research* 1, no. 1 (2011): 62.
[543] Ilisu Dam, 2011.
[544] Warner, 233.
[545] Ibid., 246.
[546] Ibid.
[547] Ibid.

(2) WATER SECURITY IN THE JORDAN RIVER BASIN

No other region requires a proactive approach to solving the question of water security as desperately as the Middle East, and the Jordan River Basin is at the nexus of this problem.[548] Most of the Eastern Mediterranean area of the Middle East depends on the Jordan River and its aquifers to survive. With an estimated area of just 18,300 km^2, the Jordan River basin is dwarfed by the moderately sized Tigris-Euphrates Basin (879, 790 km^2) and the massive Nile River Basin (3,255,000 km^2).[549] However, in terms of geopolitical consequence the Jordan basin is perhaps the most important, as equitable allocation of its resources are necessary for regional stability. The basin has five riparians, Lebanon, Syria, Jordan, Israel, and occupied Palestinian territories (OPT), though each extracts varying amounts of water. Because Lebanon and Syria consume minor amounts, this case study will focus primarily on Israel, Jordan, and the OPT. Ensuring water security is paramount to the national interests of the Jordan riparians, for without it all sectors of society are threatened. Achieving this security has been increasingly jeopardized by a changing climate characterized by less precipitation, a warmer overall temperature, and a higher incidence of drought.[550] This section will outline the hydrological composition of the Jordan River Basin, briefly explore the history of water security in the area, examine the strengths and weaknesses of existing water treaties, and look at the effects that climate change may have on water supply. Additionally, we will consider the extent to which water scarcity exacerbated by climate change could impact political relations in such a volatile region, and the possible implications for Canada.

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[548] Peter Meisen and Jenna Tatum, "The Water-Energy Nexus in the Jordan River Basin: The Potential for Building Peace through Sustainability," *Global Energy Network Institute* (June 2011): 5, http://www.geni.org/globalenergy/research/water-energy-nexus-in-the-jordan-river-basin/the-jordan-river-basin-final-report.pdf.

[549] Food and Agricultural Organization of the United Nations, "Euphrates-Tigris River Basin." March 1st, 2013. http://www.fao.org/nr/water/aquastat/basins/euphrates-tigris/index.stm.

[550] Jon T. Martin, "Climate Changes, Water Security and Possible Remedies for the Middle East," *UNESCO PCCP – The United Nations World Water Assessment Programme* (2009): 14, http://unesdoc.unesco.org/images/0018/001818/181886E.pdf.

Hydrology of the Jordan River Basin and State Water Consumption

The 250 km Jordan River is a product of three tributaries: the Banais of the Golan Heights, the Hasbani of southern Lebanon, and Israeli river Dan. After convergence the river flows quickly to the Sea of Galilee, a vital source of water for the Israelis, before snaking its way down the basin and coming to a rest at the Dead Sea.[551] The Jordan River's total flow by the time it reaches its endpoint is 1,470 million cubic meters per year (MCM/yr). For perspective, the Euphrates has a flow of 32,000 MCM/yr, while the Nile provides a yearly flow of 74,000 MCM. Three relatively large aquifers, the Mountain, Northeastern, and Eastern, provide Israel and the West Bank with a significant proportion of its freshwater. Jordan benefits from a total of twelve basin aquifers, but their total yield of 270 MCM/yr is less than the 335 MCM/yr supplied by Israel's Mountain aquifer alone.[552]

Regional water security will be acutely affected by population growth rates over the coming decades. A total of 44 million individuals currently live in the five riparian nations; however, this number is expected to exceed 73 million by the midpoint of the 21st century due in large part to a very young demographic profile.[553] Accelerated growth rates will pose a significant problem for Syria and Palestine who will be forced to revise water allocation to meet rising demand. In Israel, population growth coupled with a higher standard of living will likely push water demand above the current level of about 1840 MCM/yr, of which 37% is domestic usage, 58% for agriculture, and 5% for industry.[554] Water consumption for Palestinian residents in the OPT has been estimated at just over 180 MCM/yr, which equates to 73 liters of daily per capita consumption. Israelis are afforded about 3.5 times more daily water than Palestinians, consuming an average of 242 litres daily per capita[555]. These statistics show that water inequity is a reality in the region and stems from the lack of autonomy that Palestinians in the West Bank have over their water resources. Jordan is achieving a supply of 289 MCM/yr in part through over-drafting of its water resources, a common regional problem that will be discussed more in the section regarding climate change projections.

Climate Change Projections

Climate change projections for the Jordan River Basin are based upon regional trends observed by organizations like GLOWA (a German funded initiative studying the JRB), and on the lower/upper scenarios outlined in this report's science section. Warmer temperatures in the basin over the past few decades have already had an irrefutable impact, causing more drought and limiting sufficient natural

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[551] ICE Case Studies, "Jordan River Dispute," *Trade and Environment Database* (November 1997): http://www1.american.edu/ted/ice/westbank.htm.
[552] Ibid.
[553] Meisen and Tatum, 4-5.
[554] State of Israel, Water Authority, *The Water Issues Between Israel and the Palestinians* (February 2012): 18, http://www.water.gov.il/Hebrew/ProfessionalInfoAndData/2012/19-Water-Issues-between-Israel-and-Palestinians-Main-Facts.pdf.
[555] "Fact Sheet: Water in Israel-Palestine," *Canadians for Justice and Peace in the Middle East* 89 (July 2010): 1-2, http://www.cjpmo.org/DisplayDocument.aspx?DocumentID=1001.

replenishment of the Jordan river and basin aquifers. Predicting how much change the area will experience by 2050 is difficult; however, it is very likely that overall warming will surpass the IPCC's conservative estimate of 2ºC. Our lower scenario assumes a global average temperature increase of 2.5-3.0ºC by 2050. Research by the International Institute for Sustainable Development supports this projection, concluding that the basin will be faced by increases of 2.5-3.7ºC during summer months.[556] This will have significant drying effects in an already arid climate, leading to decreases in rainfall throughout the traditionally wetter winter months that will far outweigh any slight rainfall intensification during the dry season. Climate graphs compiled by the World Bank Group echo the IISD statistics. One exhibit in particular shows a rainfall decrease of at least 5% during the spring months in Israel, and a drop of at least 2.5% in November.[557] Less precipitation will have serious consequences for the basin. Water for use by municipalities, industry, and agriculture is already being pumped from some groundwater sources at rates over 3 times the 'safe yield'.[558] Climate change will compound this problem as a drier climate will lead to greater demand for water to irrigate increasingly arid land, and a consistent lack of rainfall will slow aquifer replenishment even further, perhaps leading to total depletion in the future. The flow of the Jordan River, which plummeted from 1.3 billion M/yr to just 30 MCM/yr over the past 50 years, will be continually threatened by overdrawing coupled with the effects of climate change.[559]

The upper scenario, estimated on a 'business as usual' global approach to climate change, provides for an average global temperature increase of 4-5ºC by 2050. A report by the United Nations World Water Assessment Programme anticipates a regional temperature rise of up to 4.5ºC by 2070, which, although 20 years past our given target, demonstrates the potential extremity of climate change. At these temperatures a 25% decline in precipitation is expected, well below the 5% drop projected for Israel under a warming of 2-3ºC.[560] With such drastic shortages of rainfall, the Jordan River may experience disruptions in flow of between 23-73%, crippling for a region that relies almost exclusively on the river and its basin runoff. If changes reach the levels outlined by our upper scenario, there is little telling the devastating impact it could have on water levels in the Sea of Galilee. Its health and resilience is currently vital to the water security of Israel as it provides 50% of the nation's drinking water, and accounts for roughly 30% of total supply.[561] In December of 2012 it was reported that due to better water management and increased

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[556] International Institute for Sustainable Development IISD, Ministry of Foreign Affairs of Denmark. (2009): 7, http://www.iisd.org/pdf/2009/rising_temps_middle _east.pdf

[557] The Word Bank Group, "The Jordan River Basin," *Climate Change Knowledge Portal for Development Practitioners and Policy Makers.* March 2013, http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_future_climate&ThisRegion=Middle%20East&ThisBcode=29

[558] Khamis Raddad, "Water Supply and Water Use Statistics in Jordan," *IWG-Env-International Work Session on Water Statistics* (June 2005): 3, http://unstats.un.org/unsd/environment/envpdf/pap_wasess4a3jordan.pdf

[559] "Projects-Jordan River," *Friends of the Earth Middle East.* March, 2013, http://foeme.org/www/?module=projects&record_id=23

[560] Martin, 7, 10.

[561] Ibid., 14.

precipitation the lake was recovering to a suitable level, however, sustained temperature change of 5ºC could eliminate Galilee as a viable water source.[562]

History of Regional Conflict over Water Resources

Conflict between the Jordan Basin riparians is far from a recent phenomenon and has its roots long before the Israeli state was even created. According to a UNESCO case study, the Zionist Organization began to work on plans to establish hegemony over the region's water supply before the turn of the 20th century. In the early 1950s, unilateral action by the states of the Jordan River basin to secure water supplies caused a series of military clashes. Conflict was sparked specifically by a Jordanian plan to divert the Yarmuk River, and an Israeli endeavour to build its National Water Carrier system inside a demilitarized zone leftover from the 1949 armistice.[563] Once again water ambitions were a factor in the 1967 Arab-Israeli War, as tensions over diversion plans led to a number of skirmishes and the destruction of some water infrastructure. The Six Day War turned out to greatly bolster Israel's regional "hydrostrategic position, because now with the Golan Heights, Israel had all of the Jordan River Headwaters within its territory... gained access to the length of the Jordan River and controlled the three major aquifers".[564] This is where Israel currently stands today, with the Golan Heights and much of the river basin firmly under its control.

Current Water Agreements

Two important agreements continue to govern water relations in the Jordan River basin to this day, the Peace Treaty signed between Jordan and Israel in October of 1994, and the Oslo II Agreement between the Israelis and Palestinians in September of the following year. Article 6 of the Oslo II is devoted entirely to water issues and lays out the framework for a permanent water allocation policy. These allocations for the Jordan River, Yarmuk River, and Arava Araba ground-waters are laid out in detail in Annex II, and give each nation a certain amount of river flow for different periods throughout the year.[565] A clear strength of this agreement is that it avoids focusing on 'theoretical water rights', and instead provides for straightforward and transparent distribution of water resources. Perhaps the most important provision of the treaty was the creation of a flexible institution to allow the nations to continue to cooperate on any matters relating to water. The result was the Joint Water Committee, a body comprised of three members from each state, capable of settling disputes over treaty provisions or hydrological changes. The JWC has proven

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[562] Israel Today Staff. "Sea of Galilee Water Level Very Encouraging," *Israel Today,* December 20, 2012, http://www.israeltoday.co.il/Default.aspx?tabid=178&nid=23579.

[563] Munther J. Haddadin, "The Jordan River Basin: Water Conflict and Negotiated Resolution," *UNESCO International Hydrological Programme* (2003): 9, http://webworld.unesco.org/water/wwap/pccp/cd/pdf/case_studies/jordan_haddadin_2.pdf.

[564] ICE Case Studies, "Jordan River Dispute."

[565] Uri Shamir, "Water Agreements between Israel and its Neighbors," *Water Research Institute Technion – Israel Institute of Technology* (May 1997): 276-277, http://environment.research.yale.edu/documents/downloads/0-9/103shamir.pdf.

its ability to be an effective multilateral institution over the past two decades, most notably when members successfully staved off conflict by cooperating to reallocate resources in the face of a 1998-1999 drought. In their report, Odom and Wolf bring up the treaty's lack of an explicit conflict resolution mechanism as a potential pitfall that could threaten water relations between Jordan and Israel in the future.[566] While such concern is warranted, the JWC has continued to foster cooperation between the two sides and appears to have the capability to adapt to stresses on the basin's water supply.

The Gaza Agreement signed in 1994 was essentially part one of two Oslo agreements that would alter water relationships between the Israelis and Palestinians. With the signing of the first agreement, the Palestinians gained control over their own water supply in Gaza and thus assumed responsibility for the maintenance of water systems within the territory. The following Judea and Samaria Interim Agreement recognized the right of Palestinians to water and set a future supply increase of 7080 MCM/yr.[567] Israel has held up its side of the agreement and has increased Palestinian water resources "by about 50 percent (60 MCM/yr in 2006, not including Gaza).[568] However the fundamental problem remains that Israel continues to invoke the primacy of its own water security at the expense of Palestinians in the West Bank. Despite a Joint Water Committee, Palestinians in the occupied West Bank have little to no say over the allocation of water from the river, and three aquifers within the region.

Implications for JRB Riparians and Canada

The Middle East, and particularly the Jordan River Basin, will face increasingly difficult water-security challenges as anthropogenic climate change intensifies over the coming years. Whether the changes fall into our lower or upper scenario, water scarcity will continue to test regional adaptability, resilience, and cooperation.

(a) Jordan River Basin Riparians:

Competition over precious resources will continue to fuel dispute, especially between, Israel and the OPT; however, it could ultimately foster greater political cooperation. The Israelis and Jordanians have, through the 1994 Peace Treaty, created a framework for regional water distribution that to date has been a successful partnership. With its creation of a Joint Water Committee to find solutions and promote efficient water policies, the agreement between the two nations is a promising model for basin management in other areas. Despite positive signs, the JWC lacks "provisions to manage a climate-induced reduction in water

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[566] Olivia Odom and Aaron T. Wolf, "Institutional Resilience and Climate Variability in international Water Treaties: the Jordan River Basin as 'Proof of Concept'," *Hydrological Sciences Journal* (July 2011): 709, http://www.tandfonline.com/doi/abs/10.1080/02626667.2011.574138.
[567] Haim Gvirtzman, "The Israeli-Palestinian Water Conflict : An Israeli Perspective," *Mideast Security and Policy Studies* 94 (January 2012): 5, http://www.biu.ac.il/SOC/besa/MSPS94.pdf.
[568] Ibid, 8.

availability...[and] measures that would relieve political stress in times of increased water stress".[569] Jordan and Israel must devise concrete plans for dealing with any consequences of climate change; migration, food insecurity, long-standing political issues, and the potential for future conflict over water, must all be considered.

Increased water scarcity in the Jordan River Basin will likely prevent the creation of an independent Palestinian state any time in the near future. Israel will not give up its hydrologically advantageous position by relinquishing control of the lower Jordan and the West Bank aquifers to the Palestinian Authority. Much like the JWC discussed above, the Israeli-Palestinian Joint Water Committee was established and designed to allow for cooperation between the two sides, although the institution's track record reflects a largely one-sided arrangement.[570] Climate change could push Israel to realign its water allocations in the West Bank, a move that could thrust OPT Palestinians into an extremely vulnerable situation. To ensure water security for its people, the Palestinian Water Authority must continue to challenge the structure of the JWC in hopes of securing more equitable operational footing. If this is achieved, the often lengthy process of approving well development and other water infrastructure projects aimed to benefit Palestinian settlers will be dramatically accelerated.[571] Israel will not willingly renounce control over its West Bank water resources, but even minor restructuring of the JWC could allow the OPT to gain greater access.

While various climate change provisions need to be generated and inserted into water treaties by the basin riparians, the only foreseeable way to avoid future conflict over water in the region is to create more supply. This is the premise behind a solution termed the "Positive-Sum Outcome", which seeks to "increase the total volume of water that is available to the parties".[572] Recognizing that conservation and efficient practices can only fend off debilitating water scarcity for so long, the Positive-Sum outcome looks to ensure water security for all riparians by focusing on widespread, cost-effective desalination efforts, better wastewater treatment, increased reliance on virtual water, and importation of water from outside sources. Israel has invested significant resources towards the development desalination infrastructure, including three large facilities and a number of smaller ones specifically for processing brackish water.[573] The Israeli Water Authority has been proactive in its efforts to incorporate desalination into its long term plans for national water security; through desalination, Israel hopes to cover 62.5% of domestic water

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[569] Odom and Wolf, 709.
[570] Jan Selby, "Cooperation, Domination and Colonisation: The Israeli-Palestinian Joint Water Committee," *Water Alternatives* 6.1 (2013): 7-10, http://www.water-alternatives.org.
[571] Ibid., 20.
[572] Al Jazeera Transparency Unit, "Transboundary Cooperation over the Jordan River Basin: The Positive Sum Outcome," (March 1, 2013): 2, http://www.ajtransparency.com/en/projects/thepalestinepapers/201218204231531190.html.
[573] State of Israel, Water Authority-Desalination Division, "Sea Water Desalination in Israel: Planning, coping with difficulties, and economic aspects of long-term risks," (October 2010): 3-4, http://www.water.gov.il/Hebrew/Planning-and-Development/Desalination/Documents/Desalination-in-Israel.pdf

demands by 2015 and 100% by 2050.[574] Israel has an opportunity to help Jordan and the OPT implement this technology with similar efficiency, which would serve to further regional cooperation. Without the looming specter of water insecurity, the JRB riparians would be able to resolve a number of resource driven disputes, which in turn could clear the way for greater political dialogue about other long-standing issues.

(a) Canadian Implications:

For Canada, the implications of climate change in the JRB will depend on future regional stability. If the riparians, particularly Jordan, the OPT, and Israel, are able to maintain cooperative relationships, honor existing water agreements, and continue to invest in adaptive measures, the outlook for a stable Middle East is promising. Conversely, if water inequity is exacerbated by scarcity and effective action is not taken to increase supply, the situation could deteriorate rapidly. Water insecurity could quickly lead to humanitarian crises in the form of protracted refugee situations, famine, and civil unrest. Political, and potentially violent, conflict could be sparked by aggressive state action to secure water resources, or as a consequence of humanitarian issues. While this does not seem likely, as explained in the above analysis, Canada must be prepared to address the security risk that a destabilized Middle East would pose. Canada would be faced with difficult decisions like whether or not to support peacekeeping, humanitarian, or military missions carried out by the United Nations, NATO, unilateral, or multilateral forces. If an Arab-Israeli conflict erupted, the United States would likely back Israel with financial and military resources, leaving the Canadian government to choose between backing the international community or its closest ally.

Climate change could alter the way in which Canada dispenses aid to both Israel and the OPT. In 2008, the Canadian International Development Agency (CIDA) launched a five-year program designed to inject $250 million into Palestinian territory in an attempt to stimulate the economy, prevent food insecurity, and provide humanitarian assistance. Through this aid package, close to 2 million Palestinians in the West Bank and Gaza Strip will receive food and other basic necessities that are often scarce in the OPT.[575] However, an increase in water scarcity would dramatically spike the amount of emergency funding needed to have the same scope it currently does; at some point the Canadian government may be forced to determine whether their strategy is the most effective way to resolve the humanitarian issue. To address the root problem, Canada could help promote regional security by funneling aid into building water infrastructure, and in particular desalination plants, in the OPT. Doing this would help keep any security risk at bay, while targeting their foreign aid to the region in a constructive manner that would allow Palestinians to emerge from Israel's hydro-hegemony.

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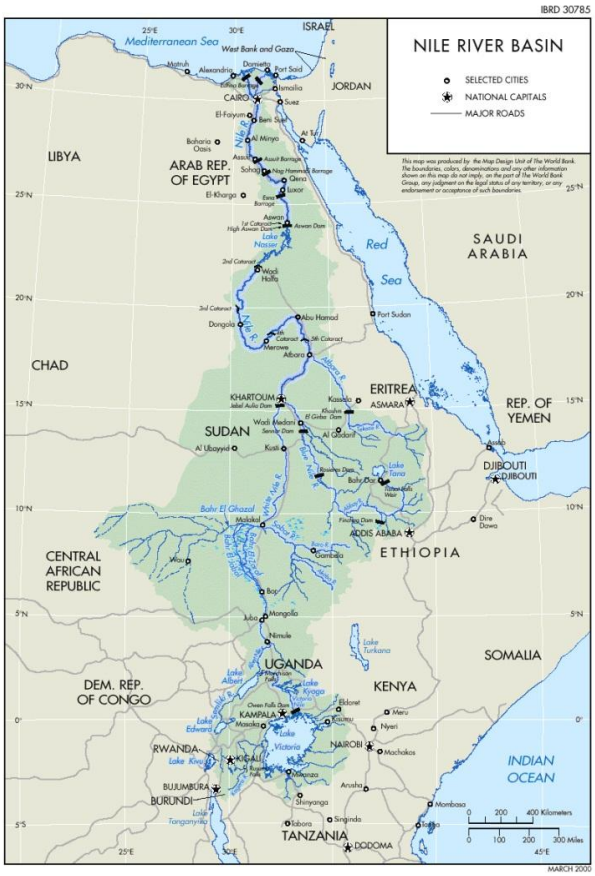
[574] Ibid.

[575] Canadian International Development Agency, "West Bank and Gaza Strategy," (2009): 3, http://www.acdi-cida.gc.ca/INET/IMAGES.NSF/vLUImages/Countries-of-Focus/$file/West-Bank-and-Gaza-Country-Strategy-2009.pdf.

(3) NILE RIVER BASIN: THE HIGH POLITICS OF WATER CONFLICT AND COOPERATION



The Nile flows 6,700 km through eleven catchment countries, with its basin covering a surface area of 3,255,000 km^2, or approximately 10% of the African Continent[576]. Basin countries include Rwanda, Burundi, Democratic Republic of the Congo (DRC), Tanzania, Kenya, Uganda, Ethiopia, Eritrea, Sudan, South Sudan, and Egypt. The Nile's two main tributaries are the White Nile and the Blue Nile, with the latter contributing 86% of its annual flow[577]. Running through both the well-endowed upstream Great Lakes region and the water-scarce downstream regions, its distribution is uneven. Of the ten riparian states, the three with the greatest level of geopolitical significance are Ethiopia, as the primary upstream water supplier, with Egypt and Sudan as primary consumers. While the current population of the basin countries is 400 million, with the three major riparians accounting for just over half of this, the projected population of Sudan, Egypt, and Ethiopia is expected to reach 340 million by 2050.[578] A growing population, in combination with limited water resources, will undoubtedly decrease regional water availability per capita.

Nile Basin: Projected Climate Change Impacts

Future effects of climate change in the Nile basin are expected to compound existing obstacles to regional water security. Despite sparse data regarding regional temperature patterns, available records indicate that climate change has contributed

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[576] Giuliano Di Baldassarre et al., "Future Hydrology and Climate in the Nile River Basin: a Review," *Hydrology Sciences Journal* 56, no. 2 (2011): 203.

[577] Asseefa M. Melesse, et al, "Hydrological Variability and Climate of the Upper Blue Nile River Basin," In *Nile River Basin: Hydrology, Climate and Water* Use, rev. ed., ed. Assefa Melesse, (New York, NY: Springer, 2011), 24.

[578] Ashok Swain, "Challenges for Water Sharing in the Nile Basin: Changing Geo-Politics and Climate Change." *Hydrological Sciences Journal* 56, no. 4, (2011): 688. For example, Egypt's dependency on the Nile as a source of 96%# of its freshwater poses a challenge to its future water security. Its current per capita water availability of 1000 m^3/year, which already qualifies as chronic water scarcity, is expected to be halved to 500 m^3/year by 2025 due to its population growth of one million every nine months. Furthermore, with issues of improper industrial waste disposal and inefficient sewage systems, water quality is a cause for concern.

to regional warming. Between 1951-2005, Ethiopia's minimum temperature increased 0.37 degrees Celsius.[579] In Kenya, an average temperature rise of 0.79 degrees Celsius per decade has been recorded. There is "high confidence that that temperatures will [continue to] rise".[580] Despite extensive research, the effects of climate change on rainfall in the Nile delta are uncertain. Regional annual rainfall varies from 50 mm/year, in Lower Egypt and the main Nile, to 1200 mm/year over the Ethiopian region.[581] Despite abundant data on past precipitation trends, future "projections of precipitation have been shown to be highly uncertain".[582] High levels of rainfall variability since the 1860s have contributed to difficulty in accurately modeling future rainfall patterns. However, with the exception of Lake Victoria, all Nile sub-basins have recently experienced slight to strong decreasing trends in precipitation associated with climate change.[583] Some sub-basins, including Bahr el Ghazel, Sobat, and Central Sudan, have recorded significant drops in annual precipitation.[584] Given unreliable rainfall projections, overall impacts of climate change on Nile River flow are uncertain. Due to large proportional contributions from the Blue Nile and Lake Victoria, variability of these sources is strongly reflected in the Nile flow record.[585] Furthermore, the degree to which increased temperatures will contribute to greater water loss to evaporation is unknown.

The effects of climate change on Nile River flow are still unknown "because of the uncertainty in projected rainfall patterns in various part[s] of the basin and the influence of complex basin management".[586] Hydrological models are particularly difficult to calibrate and validate, and "their predictive capacity in a possibly warmer planet is impossible to evaluate because of the lack of temporal and spatial data applicable to different climate conditions.[587] Thus far, divergence of climate models and IPCC scenarios have led to a high degree of uncertainty in predicting the exact consequences of climate change.

For the purposes of this study, particularly concerning water resource management in Sudan and Ethiopia, analysis will proceed based on the 2007 IPCC A1B climate projections scenario. This scenario was chosen simply because it is a mid-range scenario resulting in climate change that lies between that anticipated by other scenarios. As such it is a relatively conservative, but not overly cautious, scenario.[588]

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[579] Declan Conway, "From Headwater Tributaries to International River: Observing and Adapting to Climate Variability and Change in the Nile Basin," *Global Environmental Change* 15, no. 2, (2005): 101.
[580] Ibid., 102.
[581] Di Baldassarre, 204.
[582] Ibid., 207.
[583] Ibid., 204.
[584] Ibid.
[585] Conway, 102.
[586] Di Baldassarre, 208.
[587] Ibid., 209.
[588] See Appendix I

Agriculture of the Nile Basin: Source of Vulnerability

Agriculture is the greatest source of water withdrawal in the region.[589] All Nile basin countries have agriculture-based economies, with the sector comprising 75% of total withdrawal in the Nile basin.[590] In Egypt, Ethiopia, and Sudan, agriculture accounts for 86%, 86% and 94% of total water use respectively.[591] Unlike the Great Lakes region, where rainfall augments Nile water used for agriculture, lower basin countries are entirely dependent on Nile and groundwater for both small and large-scale farming, making "irrigation ... essential for food security in the basin".[592] Half of the Nile Basin is irrigated, of which 98.7% is in climatically dry regions of Egypt and Sudan.[593]

The Fourth IPCC report indicates that wheat, rice, and maize, crops are highly dependent on stable temperature and water availability and will be affected most adversely. Unfortunately, these three crops sustain over 90% of Egypt's agricultural sector. Additionally, there are some key unknowns regarding crop stability. With the potential for drastic temperature increases, the potential for crop disease in addition to drought and desertification are noted as serious knowledge gaps in the study of the Egyptian climate experience.[594]

In order to meet growing agricultural demands, Egypt is undertaking agricultural expansion into the Sinai Peninsula and Western desert, transferring 15.5 million cubic metres of water/day from the Nile to irrigate new farmlands.[595] While the primary purpose of expanding its agricultural cultivation is to continue to feed its rapidly increasing population, Egypt is anxious to protect its water rights. By increasing its consumption now, Egypt likely hopes, in future, to "claim as much water as possible based on the assumption of acquired rights through utilization.[596] Demonstrating that its water withdrawals from the Nile are being put to 'beneficial use' through expanding irrigation projects supports Egypt's existing claims to Nile waters. However, experts question "whether Egypt can continue to use large quantities of water for agricultural and other purposes when the needs of other countries in the upstream areas are also growing"[597].

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[589] Egypt is extremely vulnerable to climate-induced flooding in coastal regions based on current projections for sea level rise in both the Red and Mediterranean Seas. In one study that considered the impact of a 1-meter sea level rise for 84 developing countries, Egypt was ranked the 2nd highest for coastal population affected, 3rd highest for coastal GDP affected and 5th highest for proportion of urban areas affected. Additionally, the Coastal Research Institute suggests that the total area of the Nile Delta affected in 2025, 2050, 2075 and 2100 could be 153, 256, 450 and 761 km^2.

[590] Swain, 689.

[591] Ibid.

[592] Ibid., 686.

[593] Ibid., 688.

[594] 5 x 10^6 ha out of the Nile basin's total area of 10.2 x 10^6 is irrigated. Swain, 688.

[595] Swain, 668.

[596] The New Valley land reclamation project in the Western desert involves irrigating an additional 200,000 hectares of desert, while the Sinai development project plans to expand irrigated land in the Sinai desert by 250,000 hectares. Swain 300.

[597] John Waterbury, *The Hydropolitics of the Nile*, (New Haven: Yale University Press, 2002), 67.

Given Egypt's growing population, limited water, and its desert climate, achieving food security by increasing agricultural production seems inefficient. The country already imports 15.3 km^3/year in virtual water.[598] Increased reliance on virtual water, the water content embedded in certain trade goods, would allow for water resources to be redirected from agriculture to other necessary components of Egypt's economy. By increasing its virtual water imports, Egypt would alleviate some of the pressure on its overburdened water system, while providing an opportunity for economic growth in countries with excess fresh water. Other savings within Egypt's water system include economic measures for improved efficiency, rainwater harvesting, and drainage schemes as part of a capacity-building approach for Egypt's future water security.[599]

Sudan: The (Potential) Bread Basket of Africa's Booming Population

Sudan has long been faced with equally devastating and simultaneously occurring drought (including severe desertification) and flooding. Both are significantly exacerbated by climate change. Drought is a particular problem in the North and West, including Darfur. In the North, precipitation varies from close to zero (near the border with Egypt) to approximately 200mm around Khartoum.[600] Both flooding and drought produce increased pressure on land availability and agricultural yields. Although there are many factors contributing to insecurity in Sudan that have little to nothing to do with the environment, the roles of rainfall, desertification and the level of Nile waters are all deemed to be major contributing causes to the continuous insecurity facing the country: conflict, displacement and food insecurity. Despite these challenges, Sudan has been able to develop extensive water management policies over the past twenty years to take advantage of the large amount of water resources afforded to it by the Nile Basin Initiative.[601] However, the agricultural sector, which constitutes the most dominant sector of the Sudanese economy, is heavily dependent on Nile resources. Sudan is considered a sub-Saharan country, and is situated geographically at the crossroads of the three major Nile tributaries and the Atbara, thus making it the ideal area for developing a strong agricultural sector. However, "maintenance of irrigation facilities, water pricing, water rights and land tenure, efficiency of water use, and crop pricing and production policies are important issues" in further developing the agricultural sector.[602]

More than 80 percent of total water withdrawals in the Sudan are attributed to agricultural practices (compared to a world average of about 70 percent).[603]

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[598] Beyene, Tazebe, et al., "Hydrological Impacts of Climate Change on the Nile River Basis: Implications of the 2007 IPCC Scenarios," *Climatic Change* 100(2010), 453.
[599] As David Kirkpatrick of the New York Times notes, 75 percent of Egypt's wheat is imported. Given economic hardship and malaise, complicated by political conflict follwing the reolvution, it will remain hard for Egypt to afford to import more food. The multiple binds of climate change, water scarcity, economic uncertainty and political dysfunction will increase pressure and have long-lasting impacts on the state in the next decade.
[600] Allen, 2003
[601] Tropp and Jogerskog, 7.
[602] Ibid.
[603] Ibid.

However, due to a lack of agricultural development, infrastructure, and capacity building at the development level Sudan is already one of the world's largest food importers. By buying more than 50 percent of the food they consume from abroad the Sudanese are participating in the trade of virtual water.[604] However, this practice has left the country vulnerable to massive price fluctuations and trade export restrictions.[605] Because Sudan is so import dependent they are particularly vulnerable to price shocks. According to the World Bank (2005), the MENA region will have grown to a projected 430 million in 2025 from around 100 million in 1960 and the present 311 million, bringing the per capita water average to extremely worrying levels. This puts greater stress on 87 percent of water that is currently used for irrigated agriculture in the MENA region.[606]

Therefore, the further development of the agricultural sector in the Sudan in accordance with population growth will require the loosening of reins regarding water rights and affording Ethiopia sovereignty over the headwaters of the Nile. While this political move may seem counter-intuitive, it is essential to ensuring the further development and stability of the region as a whole. Due to the Grand Renaissance Dam project the potential for conflict between Egypt and Ethiopia is rising significantly as Egypt's water security is threatened. What is necessary is cooperation between Ethiopia and the Sudan whereby Ethiopia would act as the 'water tower' of the Nile Basin and Sudan as the 'bread basket'. This relationship is proposed for a variety of reasons. The first of which would be the diffusion of tensions between Egypt and Ethiopia as water-sharing becomes a more common phenomenon on the Nile. Secondly, the cooperative relationship between Sudan and Ethiopia would be characterized by strategic trade with Ethiopia, allowing access to its abundant water resources and with Sudan facilitating the transfer of agricultural products to Ethiopia to alleviate widespread food insecurity. Economic development, water management and food production should increasingly be seen as a 'regional problem' in the Nile River Basin, with Ethiopia, Sudan and Egypt collaborating to ensure a water secure future.

A cooperative agreement would benefit Sudan on a societal level as well. Most of the projected population growth has been in urban areas, where the population share is expected to exceed 70 percent by 2015.[607] The urban growth rate has been around 4 percent annually the last two decades.[608] With the continued growth of Khartoum, Africa's largest city, there will be increased water demand which their current allocation of Nile flow will not be able to sustain. Rapid population growth combined with urbanization and economic development further increases water

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[604] *Global Agriculture and Food Security*. International Institute for Strategic Studies, Strategic Survey 2011: The Annual Review of World Affairs (Abingdon: Routledge for the IISS, 2011), 109–118.
[605] Tropp and Jagerskog, 9.
[606] see, for example: Nomura Global Economics and Strategy, "The Coming Surge in Food Prices" (2010), available at http://www.nomura.com/research/getpub. aspx?pid=390252.

[607] World Bank. 2005. *Urban Development in MENA – Sector Brief*. The World Bank, Washington D. C.
; Tropp and Jagerskog, 3.
[608] Ibid.

demand, with serious implications for development and poverty reduction.[609] From a strategic perspective in sustaining growth and development in Khartoum, it is essential that Sudan develop a cooperative water sharing agreement with Ethiopia to sustain long-lasting development.

(4) CONFLICT, STABILITY AND WATER: THE WATER-DEVELOPMENT NEXUS IN THE NILE RIVER BASIN-ETHIOPIA AND SUDAN EXPLAINED

Recent political conflicts in North African states like Egypt have placed substantial stress on societies dependent on the Nile River Basin for life-sustaining water resources. The Nile Basin is also characterized by extreme disparities: "nearly 100 million residents within the basin countries live on less than a dollar a day; 98.7 percent of its irrigated lands fall in either Egypt or North Sudan; and, for half of the Nile's journey through the basin, it flows through countries that have no effective rainfall, making those countries overwhelmingly reliant on the Nile for every aspect of daily life." As noted by the 4th World Water Development Report, the Nile is 'considered a "closed" or nearly closed system as all of its renewable flows are being used to meet human demand or "fulfill environmental requirements for maintaining vital ecosystems, with little to no spare capacity left over."[610] As such water scarcity has long been a concern for countries situated along the Nile waters, particularly where water rights are concerned. Continued water scarcity will have long-term effects on the Nile Basin's social and economic potential, increase land vulnerability to salinization and desertification, and raise the risk for political.[611]

While already a source of regional disputes, with projected levels of desertification and global warming particularly high in the region, there is an increased urgency to ensure the life-sustaining waters of the Nile are accessible to all three states. As the region's population continues to climb, water availability per capita is projected to plummet, and rapid urban expansion across the North African region increasingly risks overburdening the already limited existing infrastructure and outpacing local capacities.[612]

In addition to providing an "indispensable lifeline" for the economic interests of each basin country, the Nile has also "served as the foundation for some of the oldest civilizations in the world and continues to be an integral part of its dependents'

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[609] World Bank. 2004. World Bank Group Middle East & North Africa. homepage: http://wbln0018.worldbank.org/mna/mena.nsf/All/27F2EFFC455749CE8525694A0072D3C3?OpenDocum ent; Tropp and Jagerskogg, 8.
[610] Ibid., 3.
[611] WWAP, World Water Development Report 4, 124-126; Vladimir Smakhtin, "Basin Closure and Environmental Flow Requirements," *International Journal of Water Resources Development* 24 (2) (2008); World Water Assessment programme, "World Water development report 4: Managing Water Under Uncertainty and Risk, vol. 1" (Paris: UNESCO, 2012), pp. 124–126.
[612] Michel et al., 1.

political, economic and social identities."[613] As such issues surrounding water scarcity and water management cooperation have far-reaching implications for agriculture (crop choice, growing seasons and pests)…livestock, hydroelectric power, and industry, all of which have an impact on agricultural production, food security and rural and urban livelihoods.[614]

Due to the collusion of factors noted above, it is vital that the riparian states immediately address the issue of water availability if the region is to build a stable hydrological framework.[615] While the historical experience within the region regarding questions of water management and water sharing have been contentious, it is possible that such discussions, when approached with impartiality and understanding, may facilitate cooperation between states and assist in the diffusion of some regional tensions.

Imposed Poverty: The Role of Ethiopian Water Rights in Development

With drier winters, changing rainfall patterns, depleted wells and aquifers, drought and desertification ever increasing in the Nile River Basin it is of no surprise that water rights have become an increasingly important issue, particularly between Ethiopia, which holds the headwaters of the Blue Nile within their borders, and Egypt, which claims historic rights to the Nile.[616] However, rapid population growth in Ethiopia could place it in a more competitive relationship with Sudan and Egypt for the basin's waters. According to the UN, Ethiopia's population is expected to rise from 83 million to 145 million by 2050.[617] This level of demographic development will rapidly increase demand for access to safe drinking water.

Due to the Nile Basin Initiative and its predecessors, Ethiopia has long held no political claim to the Nile waters, although they originate in its lands. This inaccessibility has held Ethiopia in perpetual poverty since decolonization. As such, the Ethiopian government is now capitalizing on their development trend and challenging the norms of the Nile Basin Initiative. While this has renewed tensions between the downstream hegemons, Egypt, and Ethiopia, it should be noted that the project will also have the power to significantly benefit its neighbours from an energy standpoint. By facilitating increased regional trade in the energy sector, increased trust and regional security is a likely result. This hydroelectric project is an important step in the development of one of the poorest nations on earth. The ability to provide basic services to Ethiopians will serve to augment regional stability, economic and traditional security and production.

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[613] Joshua Busby, Kaiba White, and Todd G. smith, "Mapping Climate Change and Security in North Africa" *Climate & Energy Paper Series* (Washington: the German Marshall Fund, 2010), available at http://www.gmfus.org/wp-content/blogs. dir/1/files_mf//galleries/ct_publication_attachments/ Busby_mappingclimatechange_oct10_final.pdf.
[614] Ibid, 14.
[615] FAO, *AQUASTAT database, 2012*, Food and Agriculture Organization of the United Nations (FAO), accessed on 12 March 2013.
[616] Caitlin Werrell and Francesco Femena, "The Arab Spring and Climate Change: A Climate and Security Correlation Series," (Center for American Progress/The Stimson Center: New York, 2013), 18.
[617] Ibid., 18.

Potential for Water-Related Conflict

Historical developments explain how downstream countries currently exert the greatest control in the Nile Basin, dividing 99% of the Nile's annual flow between Egypt and Sudan.[618] Egypt has earned a reputation for upholding its water rights through any means necessary. In 1970, Egypt threatened war against Ethiopia over the proposed construction of a dam on the Blue Nile.[619] Again, in 1979, President Anwar Sadat threatened war, stationing 50,000 Egyptian troops in Sudan in order to secure water flow downstream.[620] The 1980s saw rising tension among the 3 major riparians (Egypt, Ethiopia, and Sudan), as Ethiopia "maintained its sovereign right to develop water resources within its borders."[621] In 1990, Egypt successfully stalled Ethiopia's plans for construction of a massive dam by obstructing funding from the African Development Bank.[622]

Ethiopia has since emerged in a period of economic growth and development, paired with relative political stability. Economic growth and Ethiopia's increasing population, projected to reach 145 million by 2050, will increase local demand for water for consumption, hydroelectricity production, and irrigation (an estimated 2.2 x 10^6 ha of irrigated land will be required to meet future agricultural demands).[623] Having constructed several small dams, Ethiopia's government commenced its plan for further water diversion in 2011 through construction of the Grand Renaissance Dam, Africa's largest hydroelectricity project. Despite the Ethiopian government's claims that its consequences will be minimal, the dam is projected to "spawn water and power shortages downstream,"[624] reducing downstream flow by as much as 25% for three years upon completion.[625]

Regional Cooperation: The Nile Basin Initiative

Recently, increased regional stability has facilitated economic growth in the Nile Basin, freeing up funding previously allocated to the military.[626] Such growth, particularly in Sudan and Ethiopia, increases demand for energy and water, but also increases the ability of these countries to realize their own water resource projects.[627] Rather than increasing tensions, however, regional growth has often fostered

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[618] Michael P. Link, 2010. "Integrated Assessment of Climate Security Hot Spots in the Mediterranean Region: Potential Water Conflicts in the Nile River Basin," Working Paper.
[619] David Michel et al, "Water Challenges and Cooperative Response in the Middle East and North Africa," *The Brookings Project on U.S. Relations with the Islamic World*, (2012): 18.
[620] Swain, 691.
[621] Dina Zayed, "Egypt Asserts Rights to Block Upstream Nile Dams." *Reuters*, May 18, 2010, http://www.reuters.com/article/2010/05/18/ozatp-egypt-nile-idAFJOE64H0MP20100518.
[622] David Michel, 19.
[623] Ibid.
[624] Origins, 8.
[625] Link, 3.3
[626] Ibid.
[627] Ibid.

cooperation among riparian states. The Nile Basin Initiative (NBI), launched in 1999, represents a significant level of cooperation among all the Nile riparian states to "fight poverty and promote economic development."[628] The NBI seeks to develop Nile basin resources in a sustainable and equitable way while promoting economic development.

The NBI is comprised of three main bodies: the Council of Ministers of Water Affairs (Nile-COM), a Technical Advisory Committee (Nile-TAC), and the secretariat (Nile-SEC). Action plans are split between two subsidiary branches, one comprising the Nile, Egypt and Sudan, and the other consisting of the Equatorial Lakes Region. Thus far, the NBI has "functioned based on the strategy of securing the consensus of all ten riparian countries on less controversial issues, while postponing more difficult ones"[629]Thus, although the creation of the NBI and the projects it has undertaken to improve water management in the Nile basin represent a significant stride towards increased cooperation in the basin, riparian states remain split between downstream states, insisting on acquired rights through prior use, and upstream states, advocating a new comprehensive agreement for the basin. In the absence of cooperative action, climate change will likely contribute to rising tensions due to inadequate adaptation mechanisms, perhaps resulting in violent conflict among Nile riparians.[630]

Recommendations for Regional Adaptation

The 2011 Nile Basin Development Forum (NBDF assessed the implications of climate change in the region and concluded that "joint adaptive measures in the Nile Basin [are] crucial for strengthening the riparian countries' resilience against negative climate change impacts."[631] Solidification of regional cooperation through the implementation of a basin-wide water sharing agreement could create a "win-win" situation for all parties.[632] Ethiopia, with a high potential for hydroelectric power (HEP) production, could produce excess energy for trade in the region. Damming the river upstream would also prevent some evaporation loss.

To date, the greatest obstacle to complete cooperation among riparians has been the intense competition in the lower basin, particularly between Egypt and Ethiopia, regarding water rights. For global advocates of a new basin initiative, the most effective method of encouraging cooperation thus far has been financing. In 2001, the World Bank, launched an International Consortium for Cooperation on the Nile (ICCON), and expects to reach $3 billion in pledges.[633] Current World Bank policy, which emphasizes the potential for basin-wide cooperation to reduce regional conflict and poverty, successfully pressured Egypt to shift its foreign policy regarding

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[628] Swain, 306.
[629] Ibid., 4.1.
[630] Wael Khairy, 2011. "Climate Change and its Implications for Sustainable Development and Cooperation in the Nile Basin," Proceedings of the Nile Basin Development Forum (NBDF) Conference, 26-28 October, 2011, (Kigali, Kenya: NBDF): 27.
[631] Link., 3.3.
[632] Swain, 302.
[633] Ibid.

the Nile. Due to its economic precariousness, the World Bank's sharp reduction in funding[634] to Egypt from 1990-2000 "practically forced Egypt into expressing its willingness to cooperate." Moving forward, economic action (either by committing to, or withdrawing funding for projects) appears to be a useful tool in encouraging basin-wide cooperation.

Unused irrigation potential in the basin is greater than the total volume of water available for irrigation. In order to meet increased food demands in the face of an uncertain water supply, water use must be optimized. Sudan, with an irrigation potential of 2.75 million hectares, and Ethiopia, with 2.20 million hectares, are excellent candidates for increased agricultural activity, as both countries have the advantage of fertile soil compared to their downstream counterparts. Although Egypt has significant irrigation potential, its land is much less fertile. Despite utilizing 86% of Egypt's water withdrawal, Egyptian agriculture is unable to produce sufficient cereals for food consumption, and imports an additional 21% of its available water in the form of food.[635]

By focusing on less water intensive crops and financing upstream water projects in return for food and electricity, Egypt could contribute to more effective water distribution in the basin.[636] More stringent water management can be achieved through greater efficiency of water use. Increased regional trade in food and livestock (virtual water), as well as energy, presents a realistic solution to the Nile Basin's future water uncertainties. Furthermore, this regional integration would demonstrate the benefits of cooperation among riparians, and greatly reduce the risk of violent conflict or humanitarian crisis.

Policy Recommendations

While alleviating water scarcity has long been part of the humanitarian agenda, it was not until recently that the issue began to be evaluated from a climatic standpoint, particularly in the Middle East. "[T]o date, international and domestic responses have largely focused on bolstering supply rather than reducing demand via measures that encourage or mandate greater water conservation."[637] A change to this approach is necessary, particularly where access to the waters of the Nile has historically become a source of conflict between the Sudan, Ethiopia, and Egypt.

With a shift towards domestic conservation policies "augmenting supply allows governments to at least partially circumvent various political and ethnic tensions" that have historically accompanied the issue of water access in the Nile River Basin.[638] Facilitating a shift toward water-use efficiency has historically been met with animosity among actors in the agricultural sector, as it is considered the

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[634] World Bank funding for Egypt decreased from $550 million in 1990 to $50 million in 2000.(Swain, 303)
[635] T. Sileet et al.,"Impact of the Nile Basin Initiative on the Agricultural Policy of Egypt," Proceeding of the Regional Workshop on Water Demand Management in the Mediterranean Conference, 19-21 March 2007, (Zaragoza, Spain: UNEP), 7.
[636] Link, 3.3.
[637] Ibid., 1.
[638] Michel et al., 6.

backbone of the economies of many MENA countries. Therefore the Integrated Water Resources Management[639]strategies are considered the most feasible proposal from a politico-economic standpoint because they are based on a more "balanced consideration of both supply and demand dynamics, coordinated between multiple actors, stakeholder claims and ecosystem needs."[640] As the Brookings Institute notes in their report entitled *Water Challenges and Cooperative Response in the Middle East and North Africa,* "IWRM is based on the philosophy that all uses of water are interdependent and that water exists both as a social and economic good."[641] Within the framework of IWRM there is ample room for foreign investment, international involvement as well as domestic civil society and private sector involvement. With the water management systems in Egypt, Sudan and Ethiopia in particular characterized by extremely poor management and infrastructure, as well as grossly inadequate investment, the participation of both domestic and international actors is not only welcomed in this area but encouraged. Infrastructural development, including that of a stable water management system, is vital to the maintenance and stability of a functioning state and will increase state legitimacy in the eyes of the population.

However, one must be cautious when approaching development projects that may create parallel systems of basic service delivery- including that of clean accessible water. In the case of IWRM it is vital that all funding be funneled through state organs so as to not confuse the legitimacy of the state based on service provision. These dualities are both the most rewarding projects as well as the ones holding the most adverse risks and it is important that foreign involvement does not undermine the authority and capacity of the state, but augment it.

(5) ADAPTATION AND THE POTENTIAL FOR INSECURITY

The effects of global climate change will likely have a significant impact on an ecologically sensitive area like the Middle East and North Africa. With temperature projections indicating a future rise in overall temperature, and a decrease in

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[639] Integrated Water Resources Management (IWRM) is a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment. IWRM helps to protect the world's environment, foster economic growth and sustainable agricultural development, promote democratic participation in governance, and improve human health. The basis of IWRM is that the many different uses of finite water resources are interdependent. High irrigation demands and polluted drainage flows from agriculture mean less freshwater for drinking or industrial use; contaminated municipal and industrial wastewater pollutes rivers and threatens ecosystems; if water has to be left in a river to protect fisheries and ecosystems, less can be diverted to grow crops. The overarching conclusion is that unregulated use of scarce water resources is wasteful and inherently unsustainable. IWRM is a cross-sectoral policy approach, designed to replace the traditional, fragmented sectoral approach to water resources and management that has led to poor services and unsustainable resource use. IWRM is based on the understanding that water resources are an integral component of the ecosystem, a natural resource, and a social and economic good.

[640] Ibid.

[641] Ibid.

precipitation in this region, governments face a serious challenge in ensuring the well-being of their citizens by means of achieving water security. Understanding the potential dangers of decreased water availability, governments and industries have begun to respond.[642] Adaptation in the Middle East is of particular importance to preserve crucial agriculture sectors in the region. According to the World Bank, 88% of those economically active in the Middle East in 2006 work in some level of agriculture.[643] Ensuring water security for the sake of this vital industry will be essential to their governments.

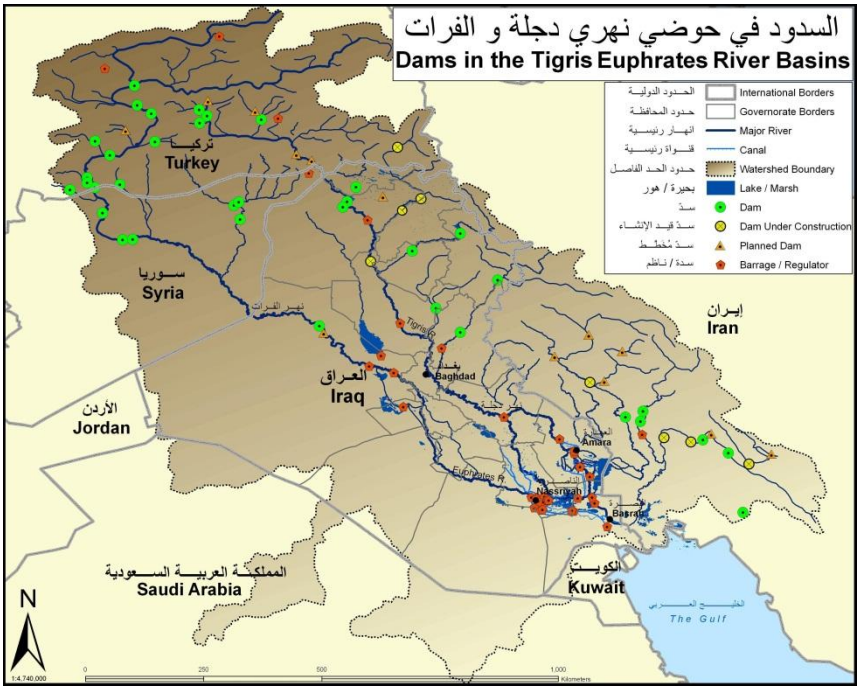

Figure 5: Major hydrological constructions and projects in Tigris-Euphrates Basin

This section will outline how various governments, particularly Lebanon, Syria, Jordan, and Israel, have initiated adaptation efforts to address future challenges to their water supplies. Adaptation and mitigation to climate change in this region will unquestionably have broader, international implications. It thus makes sense to address potential security dilemmas and political roadblocks that may occur as a result of implementation. Every country in the region has vastly different capabilities in implementing adaptation measures. The techniques utilized by one state on water resources may severely impact the ability of another to adjust, an issue which holds potential for conflict due to a history of national rivalry in the region.[644] The chief purpose of this section is to identify some of these potential challenges to regional security as a result of climate change adaptation.

Climate change adaptation techniques implemented by one state on cross-boundary water resources can have profound impacts on the security of neighbouring states, and holds the potential to create instability within the region. For instance, with alterations to water distribution systems in the Tigris-Euphrates basin by

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[642] Maurice Saade, "Syria: Impact of Drought and Climate Change on Agriculture," *The World Bank Group Development Horizons,* 1 First/Second Quarter, 2010: 20.
[643] Jon Martin Trondalen for UNESCO, "Climate Changes, Water Security and Possible Remedies for the Middle East," The United Nations World Water Assessment Programme, Paris, 2009: 13.
[644] Alex Crawford and Oli Brown, "Rising Temperatures, Rising Tensions: Climate change and the risk of violent conflict in the Middle East," *International Institute for Sustainable Development*. Winnipeg, 2009: 2.

Turkey, downstream states like Syria and Iraq could suffer serious consequences.[645] Infrastructural adjustments to create greater land-use efficiency in Turkey can alter the flow levels of the river and thus jeopardize the growing capacity of the other countries.[646] Given the lack of adequate basin-wide governance structures, miscommunication on implementation is likely.[647] This is amplified by social unrest, particularly in light of recent political turmoil in Syria. The current unrest was in part fuelled by a severe lack of water that forced many to flock to cities in hope of finding respite.[648] Such population dynamics overstress urban centres which, coupled with the oppressive nature of the Syrian regime, contributes to violent uprisings.[649] In doing so, the security of the population dependent on a consistent level of water in the basin is compromised, an issue which will only grow in significance with the rising probability of climate change-induced water stress in the region. Turkey's large scale projects to gain control of more water resources from the Euphrates-Tigris basin in addition to their lack of initiative in creating a sound tripartite treaty with its downstream neighbours Syria and Iraq (which will be further discussed later) are posing a threat to regional security, both in a traditional and human security dimension.[650] Although the politics of the Middle East are already largely shaped by geopolitical characteristics, with a projected decrease of water levels in the region and states having to adjust to this will only exacerbate the significance of these characteristics. It is possible that the power balance among riparians will be shifted to states located upstream along the major river-basins, as their adaptation methods will undoubtedly impact water level further downstream.[651] This is definitely the case with Turkey and its neighbours Syria and Iraq.[652] With the implementation of policies to increase the efficiency and distribution of water internally, states are jeopardizing the international order of the region. Differences between rich and poor will be magnified by capabilities to adapt and techniques used. For instance, Turkey's relatively large capacity allows it to undertake massive hydrological infrastructure programs to conserve water.[653] However, a major part of "Turkey's mega-project of dams and reservoirs on the Euphrates-Tigris Rivers" was compromised by a severe drought in southern Turkey and northern Syria in 2009.[654] As a result, in the year

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[645] C. Jones, et al., "Hydrologic impacts of engineering projects on Tigris-Euphrates system and its marshlands", *Journal of Hydrology* 353, no. 1-2 (May 2008): 61-63.
[646] Arie S. Issar and Eilon Adar, "Progressive development of water resources in the Middle East for sustainable water supply in a period of climate change," *Philosophical Transactions of The Royal Society* 368 (2010): 5345.
[647] Craig Kielburger and Marc Kielburger, "The Arab Spring, climate change, and Canadian foreign aid," The Ottawa Citizen, March 10, 2013, http://www.ottawacitizen.com/opinion/Arab+Spring+climate+change+Canadian+foreign/8076479/story.html (accessed March 12, 2013).
[648] Francesco Femia and Caitlin E. Werrell, ed, *The Arab Spring and Climate Change: A Climate and Security Correlations Series,* Center for American Progress, 2013, 24-25.
[649] Ibid.
[650] Joost Jongerden, "Dams and Politics in Turkey: Utilizing Water, Developing Conflict," *Middle East Policy* 17, no.1 (March 2010): 139.
[651] C. Jones, et al., 72-74.
[652] Adar and Issar, 5345.
[653] Ibid.
[654] Ibid.

between the summers of 2008 and 2009, an estimated 30% less water was released into the Euphrates-Tigris basin accessed by Syria and Iraq, causing thousands to lose their livelihoods and forcing a mass migration within those countries.[655] Turkey has thus far refused to form an agreement to accommodate a degree of international water allocation in their domestic construction plans for the southeast of the country, which aims to build twenty-two dams, nineteen power plants and many kilometres of irrigation canals.[656] It has considered the creation of new agreements on water security based on these adaptation techniques "neither necessary nor desirable", despite having signed water allocation agreements with Iraq in 1984 and Syria in 1987.[657] Examples such as this illustrate how an approach that aims to optimize the supply side of the water shortage problem can reduce the security across a vast area.

The approach to adaptation that focuses on the supply side of the water security problem that will impact the Middle East is far more popular among governments than the one that seeks solutions through managing demands.[658] This is however a dangerous approach, particularly because states have such varying capacities for this to be successful. For example, Israel is able to fairly easily create a greater supply of water for its people and as a bargaining chip by using its solar power resources to power high capacity desalinization plants. In 2009 alone these produced 20% of the water used domestically in the country, and the hope is to reach 80% by the end of 2013.[659] In contrast, other countries in the region have a far more limited financial and technological capability to conduct research and pay for modern climate change adaptation methods.[660] This further amplifies existing power dynamics and can increase regional antagonism against Israel and its supporters.[661]

If climate change adaptation in the form of technological innovation is able to create a more efficient water distribution system, it may stem the flow of people to the urban centres and coasts.[662] This could help prevent some major security issues associated with rapid urbanization. However it is unclear whether technology alone will be able to manage this, so there will now follow a brief discussion of the risks and options should demographic trends (urbanization, etc.) continue. The risks are prevalent as several large cities within the Middle East are located in coastal areas. This is particularly the case in Lebanon, where both Tripoli and Beirut are situated by the Mediterranean sea and projected sea level rises over the next thirty years may reach thirty to sixty centimetres.[663] Coastal cities in Lebanon, along with Tel Aviv,

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[655] Ibid.
[656] Jongerden, 138-139
[657] Ibid.
[658] Jeannie Sowers, Avner Vengosh, and Erika Weinthal, "Climate Change, Water Resources, and the Politics of Adaptation in the Middle East and North Africa," *Climatic Change* 104, no. 3-4 (Feb 2011): 611.
[659] Ibid., 612.
[660] Ibid., 615.
[661] Brown and Crawford, 2-3.
[662] Jonathan Chenoweth, et al., "Impact of climate change on the water resources of the eastern Mediterranean and Middle East region: Modeled 21st century changes and implications", *Water Resources Research* 47, no. 6 (June 2011), 17.
[663] Republic of Lebanon Ministry of the Environment, "Lebanon's Second National Communication to the UNFCCC," United Nations Development Programme, Lebanon. Beirut, 2009: xv.

Israel and Icel, in southern Turkey, may face problems should the climate change projections regarding sea-level rise be accurate. This would mainly be due to seawater intruding into aquifers essential to the water supply of cities and irrigated agriculture along the coasts.[664] Adaptation efforts must be made in these areas at a public policy level, to control the dangerous dynamic of population increase in coastal zones and less water availability by stimulating incentives for people to not uproot from more rural locales. This technique requires active support from the citizenry in order to be properly implemented, something which has often been overlooked in countries such as Lebanon.[665]

Issues of inefficiency, lack of governance and cohesive policy hold the potential to securitize water in the region in the future. Rita Floyd points out that security perceptions vary, and that with resources such as water it is often necessary to include "freedom from want" in the definition of security, in addition to mere absence of violent conflict.[666] Brown and Crawford suggest that this will lead to "pre-emptive seizure of resource," as countries that cannot create enough supply within their own borders may look beyond them to increase their water security.[667] The controversial notion of "land-grabbing" as an adaptation technique and its consequences of increasing potential for conflict is outlined in several sections of this report.[668] In the past, water has been an area of cooperation if shortages were encountered. However with diverging trends of decreasing natural supply and increasing regional demand the situation may well become more challenging. Water insecurities and adaptation techniques that do not accommodate for international cooperation will also greatly complicate future peace treaties, as well as existing ones, and as a result compromise the overall stability of the region. For instance, Israel's peace treaty with Jordan in 1994, which promised a certain volume of water transfers, could be void should Jordan no longer be able to sustain its transfer of resources to Israel due to climate change impacts. Since Jordan's adaptation capacity is much lower than Israel's despite a shift in focus to domestic affairs in order to attain security[669], this treaty and several others may not hold, and renewed open conflict due to lack of cooperation and interdependence could erupt. This view remains speculative;[670] however, flaring tensions between the two countries regarding water scarcity in 1999 have indicated that a securitization of water may increase to dangerous levels over long time spans,

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[664] Ibid.
[665] Richard J. T. Klein, Robert J. Nicholls, Sachooda Ragoonaden, Michele Capobianco, James Aston and Earle N. Buckley, "Technological Options for Adaptation to Climate Change in Coastal Zones," *Journal of Coastal Research* 17, no. 3 (Summer 2001): 536.
[666] Rita Floyd, "Analyst, Theory and Security: A new framework for understanding environmental security studies," in *Environmental Security: Approaches and Issues,* Rita Floyd and Richard Matthew eds. (London: Routledge, 2013), 29-31.
[667] Brown and Crawford, 28.
[668] For information on Middle East and land-grabbing see Woertz, 2013 and Selby, 2013.
[669] Philip Ian Schafer, *Human and Water Security in Israel and Jordan* (Berlin; Heidelberg: Springer e-books, 2013; SpringerBriefs in Environment, Security, Development and Peace), 110-111, http://link.springer.com.proxy1.lib.uwo.ca/content/pdf/10.1007%2F978-3-642-29299-6_8 (accessed March 31, 2013).
[670] Floyd, 31.

barring both countries developing a coinciding approach to national and human security.[671]

As a result, the capacity and techniques applied by states to adapt within their borders to accommodate for water insecurity can prove to be a major challenge to the overall security of the region, because differences among the states' resources, existing socio-economic problems and, an overall lack of cooperation could well amplify into political conflict. Without a regional cooperative approach, states' pursuit of self-interest in aiming to minimize the impact of the coming changes jeopardizes not only the water availability of neighbours, but also the overall security of the entire region.

(6) CONCLUSION: CANADA, THE MIDDLE EAST, AND WATER SECURITY

As a middle power, Canada both supports, and in some instances, competes with the interests of stronger powers' interests in the region.[672] The United States (US) and the European Union (EU) have strong capabilities and exercise their powers in the Middle East region, particularly where advantages are seen and threats perceived.[673] Hence, Canadian policy has been influenced by US and EU historically.

Canada's Foreign Policy in the Middle East during the Cold War Era (1947-1991) primarily involved impartiality, diplomacy, and various peacekeeping initiatives.[674] Canada's international decision-making has been significantly influenced by the peace and stability oriented vision of the United Nations (UN). Despite the complexity of the situation, Canada has historically positioned itself as a mediator throughout the arduous Arab-Israeli peace process. Its involvement in the Israeli and Arab dispute commenced in 1947 with passing of UN Resolution 181, which "proposed the partition of Palestine into two separate states, one Arab, one Jewish," a plan strongly supported by Lester B Pearson at the time.[675] Canada also took an active role in United Nations Special Committee on Palestine in 1947, the United Nations Relief and Works Agency in 1949, as well as advocating for peaceful resolution in the Israeli-Arab wars between Israel and Egypt, Jordan, Syria, Lebanon and Iraq. Support and monitoring of refugee situations and involvement in a UN Emergency force demonstrates Canada's willingness to serve as mediator. Security Council Resolution 242 called for a "formal peace negotiation" between Israel and

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[671] Ibid.
[672] Costanza Musu, "Canada and the MENA region: The foreign policy of a middle power." *Canadian Foreign Policy Journal* 18, no.1 (2012), 65.
[673] Ibid.
[674] Tami Amanda Jacoby, "Canadian Peacebuilding in the Middle East: Case study of the Canada Fund in Israel/Palestine and Jordan," *Canadian Foreign Policy Journal* (Vol.8, No,21, 2001), 84.
[675] Jacoby, 84.

Arab parties, a difficult task that was aided by Canadian peacekeeping presence in the Sinai Desert.[676]

Relations between Turkey and Canada have been rather strong, producing some promising cooperation. Both countries are members of the Organization for Economic Co-operation and Development (OECD), North Atlantic Treaty Organization (NATO), Organization for Security and Cooperation in Europe (OSCE), World Trade Organization (WTO) an Council of Europe (COE).[677] Turkey has embraced a "pro-Western foreign policy" since the end of World War II, and thus has extended support to certain US foreign policy objectives.[678] Canada played a direct role in stationing its troops in Cyprus in 1964 to prevent the hostilities between Turk and Greek Cypriots.[679] Moreover, Canada's recognition of Armenian genocide and its refusal to participate in the Chanak crisis of 1922, reflect the character of Canada's foreign policy. More recently, relations with Turkey have been strengthened through strong trade and commercial exports.[680] For instance, exports to Turkey resulted in approximately 1.2 billion, "making Turkey Canada's 22nd largest merchandise export market."[681] Moreover, Canadian direct investments to Turkey yielded to $1.1 billion, illustrating the strong economic ties.[682] Presently, Turkey is the "world's 17th largest economy" being an active member of G20 and its access to markets worldwide.[683]

From 1992 to 2000, Canada was heavily involved in the "Middle East peace process as chair of the refugee working group in the region of the Middle East."[684] Increases in bilateral aid to recipient countries were geared to development assistance. Canada's foreign aid to Iraq amounted to $300 million for "reconstruction assistance" in 2003 following the U.S. invasion.[685] Canada's partnership with World Bank and UN focused on regional initiatives that allowed for increased literacy, health care, access to clean water and sanitation in that region.[686] Canada's role in the resettlement of Iraqi refugees in partnership with the United Nations High Commissioner for Refugees (UNHCR) was another notable contribution to the region.[687]

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[676] Ibid.
[677] Celik and Laura Celik, "Turkey: Current and Future Political, Economic and Secuirty Trends," *Canadian Defence and Foreign Affairs Institute* (2012), 6.
[678] Ibid.
[679] Paul Gough, "Peacekeeping, Peace, Memory: reflections on the Peacekeeping Monument in Ottawa," *Canadian Military History*, Volume 11, Issue 3, (2012),5.
[680] Celik, 6.
[681] Ibid.
[682] Ibid.
[683] ibid, 1.
[684] Andrew Robinson, "Canada's Credibility as an Actor in the Middle East Peace Process,"*International Journal* 66, no.3 (2011), 695.
[685] Erin Simpson, "The Post 9-11 Security Agenda and Canadian Foreign Policy: Implications for the Global South? Key Entry Points for Action A CCIC Policy Background Paper," *Canada's Coalition to End Global Poverty* (2005), 10.
[686] Ibid, 709.
[687] Mia Gauthier, "Canadian Refugee Resettlement: A Case Study of the Process of Policy-Making for Iraqi Refugees." *The American University in Cairo, School of Global Affairs and Public Policy*. (2010), 4

The Conservative government under Stephen Harper's leadership has been a vocal supporter of Israel. The Israel-Palestine dispute has traditionally been the key issue of Canada's Middle Eastern relations. Since the creation of the state of Israel, Canada has stood by Israel's side.[688] Harper's approach to the Israeli-Palestinian dispute supports a two state solution.[689] Canada also expanded its free trade and "allowed Canadian charities to support illegal settlements" according to the perspectives of Canadian political activist, Yves Engler.[690] The government believes this approach to the dispute allows Canada to maintain a balance between protecting Israel's security interests, while recognizing the warranted grievances of Palestinians.[691] Canada's impartiality in the dispute, however, is questionable since Harper took office. Canada's support for the Arab Peace Initiative is important to the future success of regional peace agreements.[692] But our ability to lay an impartial role is threatened by the recent political tilt toward Israel.

The Middle East and North Africa will remain crucially important to Canada in coming decades. The Arab Spring uprisings that began in 2010 have had serious ramifications. The unrest was partially fueled by climate change as widespread drought resulted in crop failures, soil erosion, and consequently food insecurity.[693] These developments have tremendous geopolitical consequence for a number of reasons. First, global reliance on the region's abundant oil and energy resources present great economic risks and opportunities. Secondly, regional conflicts have the potential to impact surrounding countries and the rest of the world. Uncontrolled population and migration flows are an important issue to address as Canada has received refugee influx from Palestine, Lebanon, Iraq, and Syria. Finally, the impact of terrorist activities in the region can lead to further "political and social instability in the international community."[694] One of the key objectives Canadian foreign policy has embraced in accordance with its values is democracy promotion. However, since the election of the Harper administration there has been a visible shift towards a pro-corporate, pro-right wing approach to foreign policy.[695] Extensive budget cuts have been made for democracy promotion programs in agencies such as the Department of Foreign Affairs and International Trade (DFAIT) and the Canadian International Development Agency (CIDA).[696] Canada's current interests in the Middle East are focused on economics and security, with significant investments in Middle Eastern oil and mining companies.

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[688] David Bercuson, *Canada and the Birth of Israel: A Study in Canadian Foreign Policy* (Toronto: University of Toronto Press), 1.
[689] Musu, 69.
[690] Yves Engler, *The Ugly Canadian: Steven Harper's Foreign Policy*, (British Columbia: RED Publishing, 2012), 116.
[691] Engler, 116; Musu, 69
[692] Musu, 67.
[693] Sarah Johnstone and Jeffry Mazo, "Global Warming and the Arab Spring," *Survival* 53 (2011), 12.
[694] Engler, 116.
[695] Ibid, 7.
[696] Ibid.

While, the Middle East remains plagued with instability, ongoing conflict, and insecurity, Canada must take a leadership role in development strategies and democracy promotion in the MENA region. Canada must promote sustainability in the region as a way to prevent humanitarian disaster, and end conflict over water resources. We should seek to invest in environmental aid that is aimed "to produce an improvement in the physical and/or biological environment of the recipient country" and employs environmental protection and conservation programs and environmentally friendly development strategies.[697] This includes the conservation of biodiversity, sustainable use of natural resources and "activities that contribute to the objective of stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system by promoting efforts to reduce or limit greenhouse gas emissions."[698] Canada should focus its aid in economically related sectors such as energy, water, agriculture, rural development, transport, and sanitation.[699] Doing this will give the region its best chance at maintaining peace and stability.

(7) POLICY RECOMMENDATIONS FROM THE CANADIAN PERSPECTIVE

1. With a potential shift in adaptation focus from water supply to demand, Canada could play a role in helping regional institutions to spread the message of conservation. NGOs from Canada can assist with the public relations dimension for incentives that aim to reduce the amount of water required by people and industry. This involvement would play a helpful part in regaining some legitimacy in international environmental considerations without having to undergo serious adjustments of water consumption domestically.
2. Canadian foreign policy should also aim to ensure that regional climate change induced disasters, such as prolonged droughts in other parts of the world, do not continue to grow in significance to the Middle East. As it was indicated by Troy Sternberg in the report “The Arab Spring and Climate Change,” there is an increasing interconnectivity in the world which amplifies the significance of regional disasters beyond its borders.[700] Canadian policy should be aimed at mitigating these

[697] Organization for Economic Co-operation and Development (OECD), "Aid to Environment Development Co-operation Report 2012." *Development Cooperation Report OECD*. (2012), 1, 4.
[698] Ibid.
[699] Ibid.

[700] Femina and Werrell, ed., 9-11.

issues of interconnectivity by making use of its relative climate stability to increase direct trade with the countries that rely on at risk resources, as was the case with Egypt getting food materials from China.[701] This would aid political stability in places affected and would diversify Canadian trade and leverage by introducing new products.

3. Another profitable option for policy regarding adaptation to climate change in the Middle East would be the introduction of Canadian-made adaptation technologies into the states that have low independent capacity to create it. Such products could be utilized in these countries where scientific innovation in the field of water supply increase may itself be scarce. The benefits for Canada would be a degree of indebtedness by these countries and also an appearance of being an innovative force in international development and adaptive technology. This recommendation is based in the reality that Israel, which is at the forefront of technology in this regard with its extensive desalinization project, is not likely to provide its neighbours affordable access to their methods. Canadian policy could therefore encourage the transfer of technology from outside the region to be implemented in high-risk, low-capacity areas, and thereby begin to remedy the recent political imbalance in our foreign policy in the area.

[701] Ibid.

AFRICA

Climate Change, Water Security, and Africa

Scientific Predictions and Current Continental Challenges

Africa is the world's second-driest continent, and according to climate change predictions, it is going to continue to get drier.[702] It is very clear throughout this report that climate change will "disproportionately affect developing states" and their political stability.[703] Furthermore, many researchers have identified Africa as one of the major "global 'hotspots' for water-constrained, rain-fed agriculture. They find that people living in these 'hotspot' environments are disproportionately undernourished and they link it to climate-driven food insecurity."[704] Water scarcity in Africa is caused by more than just changes in the climate. Water scarcity is also increased by rapid population growth and urbanization, water use in food production, poor water management, and poor infrastructure. Weak institutions and low coping capacities exacerbate the problem further.

Based on the 2007 IPCC Report, Africa is generally expected to face precipitation decline in the Sahel, the Horn of Africa, and Southern Africa as well as an increase in drought and desertification.[705] As such, prominent areas of risk for water insecurity correspond with these areas. By 2020, "yields from rain-fed agriculture could be reduced by up to 50%. Agricultural production, including access to food, in many African countries is projected to be severely compromised. This would adversely affect food security further and exacerbate malnutrition."[706] Unlike some countries in other parts of the world, Africa already faces issues with water scarcity and access to clean water. Climate change is likely to perpetuate many pre-existing challenges and issues in Africa.

Africa's current challenges include: rapid "population growth, weak governance and land tenure challenges, [which has] led to increased competition over scarce natural resources – most notably fertile land and water – and resulted in tensions and conflict between communities."[707] In combination with poor development, fragile agricultural economies, pervasive poverty, and weak institutional and governmental capacity, Africa's adaptive abilities to counter water scarcity are extremely low.

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[702] United Nations, "International Decade for Action 'Water for Life'," https://www.un.org/waterforlifedecade/africa.shtml.
[703] Clionadh Raleigh, "Political Marginalization, Climate change, and Conflict in African Sahel States," *International Studies Review* 12 (2010): 69.
[704] United Nations Environment Programme (UNEP), "Africa Water Atlas," Division of Early Warning and Assesment (2010), 2.
[705] Intergovernmental Panel on Climate Change, "Climate Change 2007: Synthesis Report," IPCC Fourth Assessment Report, http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_sysnthesis_report.htm (accessed March 16, 2013), 30.
[706] IPCC, "Climate Change 2007: Synthesis Report," 50.
[707] United Nations Environment Programme (UNEP), "Livelihood Security: Climate Change, Migration and Conflict in the Sahel," (2011): 9.

Due to limited space, this section will attempt to deal with diversity in Africa by examining three main issues that will affect the majority of water stressed areas in Africa: agriculture, health, as well as water governance and management. This will be done by surveying and synthesizing current literature and predictions on the subjects. Many of the impacts that will affect Africa are not considered important in a traditional security sense. Rather, most of the negative impacts of water scarcity in Africa primarily concern human security and the potential repercussions of that insecurity. War-torn Somalia is a prominent case "where drought has killed far more children than military clashes or terrorist bombs. When drought turned to famine in 2011, tens of thousands…perished. More than half of Somalia's entire population were in famine zones."[708] Most of the concerns in Africa have very little direct implications for Canada. Nonetheless, if Canada is to take a more prominent normative role in international relations, Africa is the center of greatest need. Africa

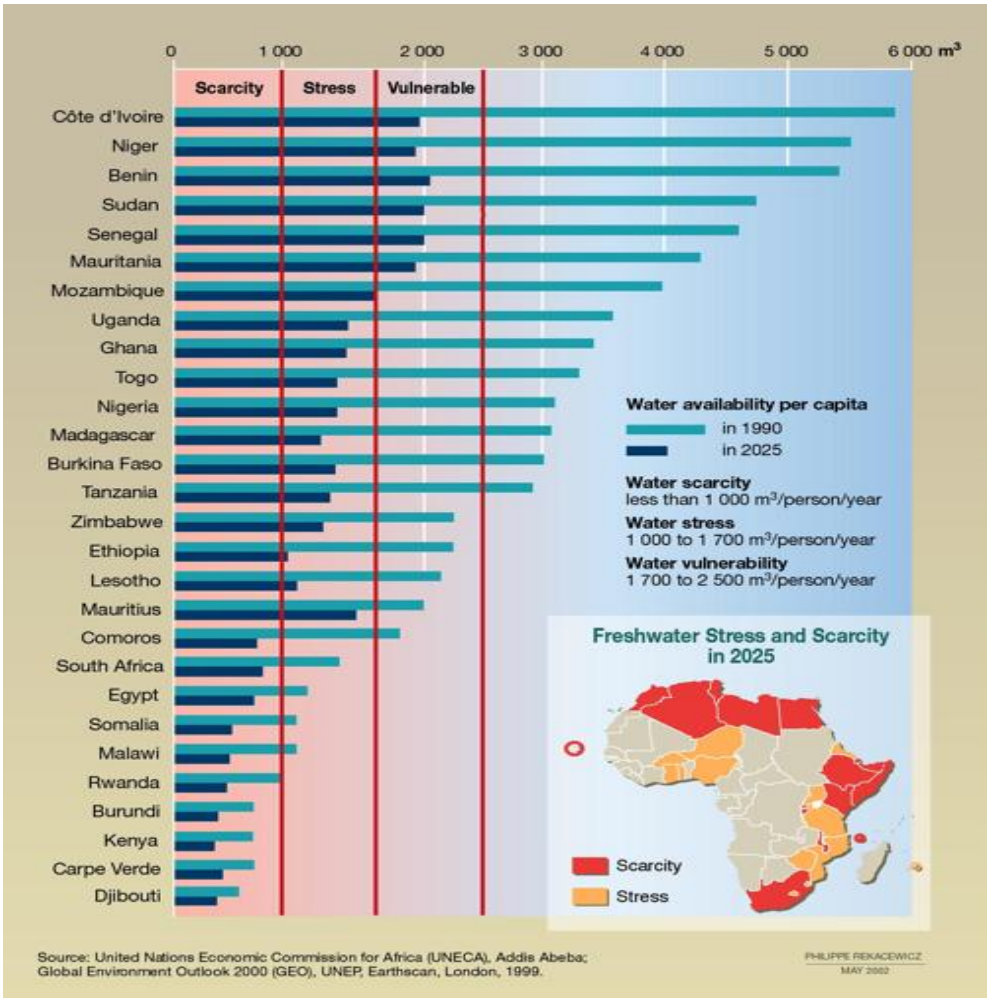

Figure 1: This graph highlights expected water availability levels in Africa. It outlines water stressed, vulnerable, and scarcity levels.

Source: International Water Law Project, "The Future of Africa's Water Security," (May 2012), http://www.internationalwaterlaw.org/blog/2012/05/27/the-future-of-africas-water-security/.

is of great concern because they will be the hardest hit by climate change, least able

[708]Geoffrey York, "Drought: How Science Can Help Save Africa," The Globe and Mail, (March 29, 2013): http://www.theglobeandmail.com/news/world/drought-how-science-can-help-save-africa/article10547612/.

to adapt, and are already suffering from land and water shortages. As some scholars have argued, "scarcity can sharply increase demands on key institutions, such as the state, while simultaneously reducing their capacity to meet those demands."[709] These trends will have impacts on Canada. In light of recent Canadian participation in Libya and now Mali, it is clear that Canada can be drawn into expensive security problems in Africa. It is imperative that Canadian foreign policy makers understand the costs of military intervention and the areas in which they are engaged. This will be discussed further in the section Canada and Africa.

(1) PRESSING ISSUES ASSOCIATED WITH WATER SCARCITY: AGRICULTURE, HEALTH, AND GOVERNANCE AND MANAGEMENT:

(a) Agriculture

One of the most important problems associated with water scarcity in Africa is agricultural security and its impacts on livelihoods. Increased scarcity will negatively affect livelihoods especially for small farmers and pastoralists. This is expected to increase current migration patterns, thereby reducing state capacity, especially in rapidly growing urban settings without proper infrastructure. Another matter that complicates Africa's situation further is instances of land grabbing where wealthy countries buy or lease lands to produce food for export to other countries. This further negatively affects livelihoods and economic stability.

Agriculture remains the dominant means of livelihood in Sub-Saharan Africa. These practices have become increasingly disrupted by development policies and climate change. With four-hundred-million chronically poor people, and almost half living in Sub-Saharan Africa, greater support is necessary for livelihoods at risk. The disruption of livelihoods from climate change, combined with inadequate adaptation policies, will only increase the numbers living in poverty. In Sub-Saharan Africa, the dominant means of generating a living consists of small-scale subsistence farming, pastoralism, and hunting/gathering livelihoods. These practices are extremely resource-dependent; however, access to water is becoming increasingly constrained in this region, and even more difficult for already marginalized communities. Climate change is expected to, and in parts of Africa has already begun to, alter the dynamics of drought, rainfall and heat waves. It is also anticipated to trigger secondary stresses such as the spread of pests, increased competition for resources, the collapse of financial institutions, and attendant biodiversity losses. As drought increases in frequency and severity, this will result in crop failure, high and rising cereal prices, distress sale of animals, de-capitalisation, impoverishment, hunger, and eventually famine. Evidence from the IPCC suggests that areas of the Sahara are likely to

[709] Thomas F. Homer-Dixon, "Environmental Scarcities and Violent Conflict: Evidence from Cases," *International Security* 19 (1994): 6.

emerge as the most vulnerable to climate change before 2100 with likely agricultural losses of between 2 and 7% of GDP. Western and Central Africa are expected to have losses ranging from 2 to 4% and Northern and Southern Africa are expected to have losses of 0.4 to 1.3%. Population growth has also increased the demand for food, hence the need for higher crop yields. This has led to more intensive land use resulting in nutrient mining and soil degradation. These tensions are exacerbated by the lack of institutional support and government capacity to coordinate with locals to adequately deal with climate change. Greater coordination is necessary at the local, national, regional, and international level in order to respond to the demands and constraints in the agricultural sector.

Agro-pastoralism is the most widespread method of sustenance in Sub-Saharan Africa. It occupies the semiarid zone of West Africa, and substantial areas of East and Southern Africa.[710] The movement of pastoralists is dictated by resource availability, in search of pastures for livestock. Cultivation is rare and the population is extremely mobile.[711] Due to low and variable precipitation in pastoral regions, as well as a lack of permanent water supply, permanent settlement is difficult.[712] Pastoralists require access to a complex set of vegetation communities to maintain the animals' condition, productivity, and population stability.[713] East Africa is home to thousands of pastoralists who herd their livestock in the semi-arid to arid areas of the region. Rainfall sensitivity affects the ability to forage, livestock production and, ultimately, the livelihoods of these populations.[714] In West Africa, pastoralists and agriculturalists have combined their practices, and have established a complex system through which mobility is alternated amongst agro-pastoralists in the region, depending on the season, to ensure equal access to water sources.[715] Climate change, particularly with regards to water access, has significantly disrupted these systems. Mobility systems organized around water access, such as the pastoral units developed in Senegal around the existing boreholes, are no longer sufficient to respond to climate variability. This has seriously disrupted local livelihoods across the region and has forced many communities into a chronic state of poverty. This could potentially increase competition for resources among agro-pastoralists and small-scale farmers, as pastoralists seek out resources in other communities. These conditions are worsened by development policies that have been imposed by the West, particularly with the spread of large-scale farming, as well as state-level policies that do not compliment local realities.

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[710] "Introduction to Pastoralism." FAO Corporate Document Repository, http://www.fao.org/docrep/005/Y2647E/y2647e02.htm#TopOfPage

[711] Hanne Adrianson, "Understanding pastoral mobility: the case of Senegalese Fulani," *The Geographical Journal* 174 (2008): 215.

[712] Adrianson, 209.

[713] Kathleen A. Galvin, Philiip K. Thornton, Randall B. Boone, and Jennifer Sunderland, "Climate variability and impacts on east African livestock herders: the Massai of Ngorongoro Conservation Area, Tanzania," *African Journal of Range & Forage Science* 21 (2004): 184.

[714] Galvin et al., 183.

[715] Mark Moritz, "Crop-livestock interactions in agricultural and pastoral systems in West Africa," *Agriculture and Human Values* 27.2 (2010): 120.

Many farmers have been reluctant to adopt different adaptation methods, as the return for investment in these practises is extremely unpredictable due to the uncertainties surrounding climate change in this region.[716] There is evidence that rural communities and households continue to demonstrate tremendous adaptive capacity in the face of economic and social change, but this capacity needs the appropriate social, institutional and political support in order to be successful.[717] In a study conducted in Cameroon, it revealed that, although local adaptation strategies were present, there was an increasing demand from the people in the North for the government to provide more resources and irrigation infrastructure to deal with increasingly low soil moistures, peaking daily temperatures, and runaway evapotranspiration.[718] Cameroon consists of three major agro-ecologies. These include the humid, moist, forest zone of Ambam, the high savannah zone of Bamenda, and the Sahel savannah zone of Garoua.[719] Agriculture employs 70% of the labour force and supplies 44% of the GDP.[720] Cameroon's weather patterns vary greatly across the region. Rainfall is highest at the coast but decreases steadily northward.[721] The rainfall is variable and unreliable, and floods, frosts, and drought occur frequently.[722] The study found that net revenues fell as precipitation decreased. Surface water runoff also had a significant impact on farm revenues. Some farmers have responded by adopting new technologies and changing crop mixes. Few farmers can afford the costs of modern irrigation systems, however, rainwater harvesting has been used to cushion the negative impacts of drought.[723]The study considered two climate change scenarios. One examined the impact on agriculture if there is a 2.5 °C increase and the other if there is a 5 °C increase. The first scenario concluded that roughly $0.5 billion would be lost in farming revenue, while the other found revenues would fall by $19/ha.[724] There is a significant loss in revenue in relation to a decrease in precipitation as opposed to temperature increase due to the dependence on rain-fed agriculture. Existing adaptation strategies may not be enough to deal with rising temperature and a decrease in precipitation. Irrigation systems are needed in order to deal with the changing climate as well as greater support from the national government.

The Cameroon example is meant to demonstrate the need for locally-specific adaptation models which respond to environmental as well as socioeconomic conditions of a country. Governments need to be aware of local conditions in order to support adaptation policies which adhere to local needs and demands. In the case of

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[716] Cooper et al. 329.
[717] Philip K. Thorton, Peter G. Jones, Polly J. Ericksen, and Andrew J. Challinor, "Agriculture and food systems in sub-Saharan Africa in a 4◦C+ world," *Philosophical Transactions of the Royal Society 369* (2011): 118.
[718] Ariel Dinar, *Climate Change and Agriculture in Africa: Impact Assessment and adaptation strategies*, (London, Earthscan, 2008), 55.
[719] Dinar, 55.
[720] Dinar, 24.
[721] Dinar, 24.
[722] Dinar, 24.
[723] Dinar, 62.
[724] Dinar, 62.

Cameroon, cropping systems and types of cultivation vary throughout the country, as well as the impact of climate change. Crop water demands must dictate the policies which are pursued, and this could mean changing cropping patterns and the crops chosen to be cultivated.[725] The type of agricultural production must also be taken into account. Pastoralists will require different adaptation strategies than small-holder farmers who are settled in a specific territory. Local realities must dictate development policy in order to build a stable means of livelihood. The agricultural sector should be the focus of these policies as it supports the majority of livelihoods in Africa.

Development policies often constrain more than they enable poor people's access to resources and income, prioritizing investment over equity. This approach to development is more likely to benefit local elites, the private sector, and the state, rather than the poor.[726] Governments are now marginalizing pastoralists and hunter-gatherers, who have tended to the land for centuries. Policies promote state and foreign interests, and the poor are effectively made invisible, and are not consulted with or involved in the development process.[727] Increased pressures from the World Bank have promoted export diversification into non-traditional crops with highly demanding production and market requirements that are not sustainable in many African communities. This has seriously disrupted traditional production systems. These policies only increase the marginalization of these populations and limit their access to essential resources. The identities of many of these communities are governed by traditional agricultural practices and a disconnect exists between these identities and development policies. As climate change intensifies and water access becomes increasingly constrained, agricultural practices will continue to be disrupted and more people will be living in a state of chronic poverty. Adaptations strategies are necessary in the agricultural sector in order to cope with limited access to water as well as support existing pastoral agricultural systems. When human livelihood is affected, people will move to urban or resource rich areas where they have more opportunities. The strain placed on states when this happens can be very burdensome and in the worst case scenario, result in civil conflict.

There is a need for greater communication as well as coordination between state officials and local populations. Adaptation policies that already exist at a local level need to be supported on a broader scale. The state must enable these systems of mobility. There is also a need for combining different forms of knowledge systems. Local knowledge is extremely valuable and essential to create a sustainable response to growing water scarcities. This should be combined with scientific knowledge systems in order to create a more well-rounded understanding of the challenges that must be overcome. Technological transfers that are based on local needs and demands can aid adaptation strategies. Both international and domestic actors, must recognize the value of local opinions and support them through their policies, thereby

[725] Dinar, 55.
[726] Kinsella, 52.
[727] Ibid, 57.

creating a more genuine dialogue among local communities, district authorities, and the central government.

There is a need for greater communication as well as coordination between state officials and local populations. Existing local adaptation policies need to be supported on a broader scale. New adaptation strategies are also necessary, which complement existing local systems. As emphasized by experts on local adaptation, these new practices must build upon strategies and farming practices that local communities and farmers already use. For livestock, there are several approaches, including movement of feed resources and/or of livestock over what may be large distances, where this is feasible, as mobility has been demonstrated as the key strategy that pastoralists rely on to maintain their herds during periods of drought.[728] In parts of East Africa, herders are switching from cattle and sheep to camels and goats. As for certain crops, some livestock species and breeds are better able to deal with dry and drought conditions than others.[729] During East African droughts, some negative impacts have also been countered by digging and maintaining sand dams in river bottoms. The dams allow for continued cattle watering during dry periods, and have reduced cattle deaths and conflict.[730] There is also a need for combining different forms of knowledge systems. Local knowledge is extremely valuable and essential in order to create a sustainable response to growing water scarcities. This should be combined with scientific knowledge systems in order to create a more well-rounded understanding of the challenges that must be overcome. Technological transfers, which are based on local need and demand, can aid adaptation strategies. No African climate research institutions are involved in producing GCM models. Because of the lack of the necessary tools, both human and instrumental, Africa depends, to a very large extent, on institutions based in Europe and North America for its operational climate capacity.[731] International actors, as well as local state actors, must recognize the value of local opinions and support them through their policies, creating a more genuine dialogue among local communities, district authorities, and the central government.

Migration, in combination with rapid population growth, can place substantial demands on host states, "Rapid population growth and urbanization… [can] put enormous pressure on municipal water sources."[732] The latent effects of environmental change in rural areas can cause migration to urban areas, which can place "increasing demands on [social] services and increasing political pressure on the state, which in itself is an important provider of various entitlements such as education, health care, law and order, credit, and protective security."[733] Rapid population growth and migration can, in turn, slow the process of providing people

[728] Thorton, 124-125.
[729] Thornton, 125.
[730] Rockefeller, 20.
[731] Rockefeller, 28.
[732] UNEP, "Africa Water Atlas," 17.
[733] Jon Barnett and W. Neil Adger, "Climate Change, Human Security, and Violent Conflict," *Political Geography* 26 (2007): 642.

with access to the water and sanitation they so desperately need. Many people in the international community as well as academics are concerned about the outbreak of violence. Such violence can be due to migration, ethnic conflict, or civil conflict in the event of state failure. While there is no direct evidence for human insecurity and violent conflict over water insecurity, it is still a matter of concern. While instability in Africa does not directly affect Canada, the Canadian International Council's Report "Positioning Canada for the Africa of 2015" is concerned with the "blowback effects" of instability: "the grim blowback should instability, terrorism, crime, piracy, endemic disease and ecological degradation radiate outward from a failed and fragile continent."[734] In many areas of conflict, like Darfur, there is a distinct environmental issue that underlies the violence. The dispute erupted over conflicts between ethnic groups over water and land. Furthermore, the conflict is divided not only on ethnic lines but also between farmers and pastoralists. In this instance, effective water governance and management may be critical in ensuring peace and an end to the conflict in Darfur.

According to the IPCC Synthesis Report on Water, "One-third of people in Africa live in drought prone areas and are vulnerable to the impacts of droughts… which have contributed to migration, cultural separation, population dislocation and the collapse of ancient cultures."[735] Due to the fact that the agricultural sector of society is the foundation of many African economies, GDPs, and local incomes, water scarcity poses a serious threat to the well-being and stability of Africa. Without a strong economy, governments can lose the capacity to provide social services and fulfill state obligations to their people. As noted previously, when the social contract with the state breaks down, civil conflict and tension can arise, resulting in human security issues that have the potential to turn into a traditional security issue.

Another issue Africa's agriculture faces in the wake of increasing water scarcity is foreign land-grabbing. Large-scale investment in African farmland has increased since the food-fuel-finance crises of the past five years.[736] The rise in food prices in 2007/8 prompted countries to secure the food and water demands of their growing populations, the rise in fuel prices led companies to develop and produce a renewable source of fuel known as biofuel. The financial meltdown also incited a shift towards 'safe' investments that promise demand such as food and fuel.[737]The growing interest in African land has been labeled as the "second scramble for Africa."[738] Equally important as the land that is being acquired by foreign investors is the

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[734] Canadian International Council, "Positioning Canada for the Africa of 2015," (November, 2009), https://docs.google.com/viewer?a=v&q=cache:BuN35DTIGuYJ:www.opencanada.org/wp-content/uploads/2012/02/Africa-2015-Report-of-the-Seminar-2010-01-151.pdf+&hl=en&gl=ca&pid=bl&srcid=ADGEESjclbwKBuIRfTpYl2gmMWkp5dzY6NY-v8u1uGcXOIhDqYXfnht8XiWI1MoO2hlrgJu6kNiturQ73stOZpLZ71VfVHPS7O93JglhV1hh0vJO2uCoLWXQc8i-iMI02QOmHao68dv7&sig=AHIEtbSa5xUGy9kOYWHoz2gibrOxI7IMyA.

[735] IPCC, "Climate Change and Water," 80.

[736] Hall, Ruth. "Land Grabbing in Africa and the New Politics of Food." *Future Agricultures Consortium*: Policy Brief 041, 2011

[737] Ibid, 2.

[738] "Obang speaks about the land, water and resource-grabbing and Its impact on food security in Africa" Farmlandgrab.org, Sept 2012

access to abundant water resources the region offers.[739] Much literature on the topic exists, as it is a matter of contention between large international agencies and civil society organizations.[740] As of 2012, Grain documented over four hundred instances of land-grabs worldwide.[741] Of the thirty-five million hectares recently sold or leased, approximately sixteen million of it is African land.[742] These figures only represent formal land grabs, while many informal land deals are still underway across the continent.[743]

The World Bank, UN agencies and governments promote land acquisition as 'Responsible Agricultural Investment.'[744] In 2010 the World Bank released seven principles that foreign agents may voluntarily endorse and which transform "land-grabs" into beneficial investments for both local communities and investors, thereby legitimizing the investments.[745] This region is targeted because state capacity is weak, much of the land is uncultivated or producing below its potential, the land has available water resources, and it is not already secured by land titles.[746] The World Bank affirms, "One of the highest development priorities in the world must be to improve smallholder agricultural productivity, especially in Africa."[747]

Food cannot be grown without water. These vast areas being acquired will have serious implications on water resources as the land comes under cultivation. Most of the land deals are concentrated in regions that are served by the continent's largest water systems, especially the Nile and Niger River Basins.[748] The local populations depend on these basins for survival, and they are rarely consulted or involved in projects prior to the land being leased or sold to foreign investors.[749]

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[739] Grain, *Squeezing Africa Dry: Behind Every Water Grab is a Land Grab Grain*, Barcelona, Spain, 2012.
[740] http://www.grain.org, Deininger, Klaus ,Derek Byerlee, Jonathan Lindsay,Andrew Norton, Harris Selod, and Mercedes Stickler. "Rising Global Interest in Farmland: Can It Yield Sustainable and Equitable Benefits?" *The World Bank*: Washington, DC. 2011
[741] Grain, *GRAIN releases data set with over 400 global land grabs.* http://www.grain.org/article/entries/4479-grain-releases-data-set-with-over-400-global-land-grabs (accessed 2 April 2013)
[742] Grain, *Land Grab Deals*. Barcelona, 2012.
[743] Food and Agriculture Organization. *Africa's Changing Landscape: Securing Land Access for the Rural Poor* (Rome: FAO, 2010), 2.
[744] Grain, *The Great Food Robbery: How Corporations control food, grab land and destroy the climate* (Barcelona: Grain and Pambazuka Press , 2012), 158.
[745] PRAI: 1. Land and resource rights: existing rights to land and natural resources are recognized and respected. 2. Food Security: Investments do not jeopardize food security, but rather strengthen it. 3. Transparency, good governance and enabling environments: processes for accessing land and making associated investments are transparent, monitored and ensure accountability. 4. Consultation and participation: those materially affected are consulted and agreements from consultations are recorded and enforced. 5. Economic viability and responsible agro-enterprise investing: Projects are viable in every sense, respect for the rule of law, reflect industry best practice, and result in durable shared value. 6. Social sustainability: Investments generate desirable social and distributional impacts and do not increase vulnerability. 7. Environmental sustainability: Environmental impacts are quantified and measures taken to encourage sustainable resource use, while minimizing and mitigating the negative impact. FAO, IFAD, the UNCTAD Secretariat and the World Bank Group. Principles for Responsible Agricultural Investment that Respects Rights, Livelihoods and Resources. 2010.
[746] Hall, 4-6.
[747] Deininger, Klaus ,Derek Byerlee, Jonathan Lindsay,Andrew Norton, Harris Selod, and Mercedes Stickler. "Rising Global Interest in Farmland: Can It Yield Sustainable and Equitable Benefits?" The World Bank: Washington, DC. 2011. xiii
[748] Grain, Squeezing Africa Dry. 3-11
[749] Ibid,13-14

Indigenous farmers and pastoralist have developed adaptation methods to adhere to regional and seasonal changes in water availability, which often include migration. Host governments consider these lands to be 'wasted' or unused because they have no formal owners; therefore, the property rights are available for purchase or lease by international investors.[750]

Irrigation techniques are implicit in project planning and agreements, as investors aim to achieve the highest possible crop yields.[751] Most regions in Africa have not been introduced to irrigation technology and therefore their water resources are considered untapped.[752] Scholars have concluded that, "While climatic changes are likely to have only rather small effects on water availability, population and economic growth as well as expansion of irrigated agriculture and water transfers will have very important transboundary impacts."[753] However, there have been changes in rainy season patterns in West Africa, which has seriously affected agricultural productivity, as many farmers and pastoralists depend on rainfall for their crops.[754] Introducing irrigation techniques could greatly benefit both local and global populations if proper regulations and distribution polices are implemented.

The Office du Niger, located in Mali, is a semi-autonomous government agency and one of the largest and most important irrigation projects in West Africa. At present, corporations from Canada, China, Libya, Saudi Arabia, South Africa, the United Kingdom, and the United States have invested in the region, with other nations showing interest in the initiative.[755] Located in Mali's main agricultural area, these projects irrigate from the Niger River Basin.[756] The Malian government has sold or leased 470,000 hectares of land, but some experts conclude that the basin will only have the capacity to irrigate 250,000 hectares.[757] Nine of the sixteen current land deals are biofuel investments.[758] Half of Mali's populations live below the poverty line.[759] Although these crops serve as a more 'green' fuel replacement, they do not aid in the alleviation of food and water insecurity that many Malians face. The Food and Agriculture Organization notes that, "only a tiny percentage of total land allocations has actually been developed,"[760]leaving the economic, social, political and environmental impacts of these land-grabs yet to be experienced. Malibya, a Libyan

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[750] Hall, 3.
[751] Grain. Squeezing Africa Dry. 14
[752] Deininger, Klaus ,Derek Byerlee, Jonathan Lindsay,Andrew Norton, Harris Selod, and Mercedes Stickler. "Rising Global Interest in Farmland: Can It Yield Sustainable and Equitable Benefits?" The World Bank: Washington, DC. 2011. xvii
[753] Beck, L. and T. Bernauer, "How will combined changes in water demand and climate affect water availability in the Zambezi river basin?" *Global Environmental Change* 21.3 (2011): 1
[754] Grain. Climate Change in West Africa-the Risk to Food Security and Biodiversity. Barcelona, 2009.
[755] Grain, *The Great Food Robbery*, 133.
[756] Grain, The Great Food Robbery, 131.
[757] Grain. Squeezing Africa Dry. 13
[758] The Oakland Institute. Understanding Land Investment Deals in Africa-Country Report: Mali. Oakland, California, 2011. 23
[759] International Human Development Indicators. Country Profile: Mali. http://hdrstats.undp.org/en/countries/profiles/MLI.html (accessed 2 April 2013)
[760] Food and Agriculture of the United Nations. Trends and Impacts of Foreign Investment in Developing Country Agriculture: Evidence From Case Studies. Rome, 2012. 237

sovereign fund, has acquired one hundred hectares within the Office du Niger at no charge for fifty years.[761]The project claims to promote food security in the region but only negative consequences of the deal are being felt by Malians.[762] Some problems that have been outlined with this particular land grab are the absence of community consultation about the project, the disruption caused to villages with the construction of a forty-kilometer irrigation canal, the contract does not require crops to be bought or sold in Mali, and it places no limit on the amount of water used for cultivation.[763] In 2010 civil society organizations and smallholder representatives participated in the "Kolongotomo Farmers' Forum on Land Grabs in Mali."[764] Their appeal to the Office du Niger demanded transparency and justice in large-scale land acquisition, which unfortunately has fallen on deaf ears.[765] This instance of land-grabbing shows that while foreign investments in Africa can help food production by using water more efficiently, the benefits rarely reach the local populations.

In reference to African land deals the World Bank recognizes that, "to reduce risks and increase benefits, greater effort will be needed to identify local comparative advantage, assess the technical viability of proposed investments, improve weak institutional frameworks for land governance, and level the playing field for smallholder competitiveness."[766] Land is considered an economic commodity to foreign corporations and agencies, but to local populations it is the foundation of their social identity and their means of survival. The victims of these land deals are teaming up with international NGO's to protest the rise in 'land grabs' and their case is gaining momentum as more and more people are negatively affected by the investments. As climate change continues, it is likely that these issues will be exacerbated.

With the climate changes outlined earlier, Africa's current challenges are likely to worsen, especially if current water usage patterns continue. Droughts and famines can be extremely damaging to African countries with agriculturally based economies. Droughts have particularly affected the Sahel, the Horn of Africa and Southern Africa, especially "since the end of the 1960s, with severe impacts on food security and, ultimately, the occurrence of famine."[767] The most at risk countries for the implications of water insecurity are those with economies are primarily agricultural and as such devote a significant amount of water-usage to this sector. The following numbers are some percentages of water use for agricultural sectors: Ethiopia 93.7%, Somalia 99.5%, Mali 90.1%, South Africa 62.7%, and Swaziland

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[761] The Oakland Institute. Understanding Land Investment Deals: Malibya in Mali. Oakland, 2011.
[762] Ibid, 1.
[763] The Oakland Institute. Country Report: Mali. 26-28.
[764] Kolongotomo Farmers' Forum on Land Grabs in Mali. *Kolongo Appeal*. 20 November 2010. http://pubs.iied.org/pdfs/G03055.pdf (accessed 2 April 2013)
[765] Kolongotomo Farmers' Forum on Land Grabs in Mali
[766] Deininger, Klaus ,Derek Byerlee, Jonathan Lindsay,Andrew Norton, Harris Selod, and Mercedes Stickler. "Rising Global Interest in Farmland: Can It Yield Sustainable and Equitable Benefits?" The World Bank: Washington, DC. 2011. xvii
[767] Intergovernmental Panel on Climate Change (IPCC), "Climate Change and Water," (June 2008): 80.

96.6%.[768] These countries are in areas where climate change will compromise both water security, and their agricultural economies. While these numbers show extreme dependence on water, they also demonstrate an area where science and technological innovation may be able to make the biggest impact. Located in one of the most arid areas of Africa and the Sahel, Chad's

> desert is steadily expanding and the rain is disappearing. One of Africa's biggest lakes, Lake Chad, is dramatically shrinking. It has lost 95 per cent of its since the 1960s, partly because of climate change. The region around the lake was once the breadbasket of the country.[769]

In addition, since the 1990s and the shrinking of the lake, the crops in the area have decreased by 40 to 60 percent.[770] If technology is available, such as drought resistant crops, areas like Chad may benefit substantially. Such technology is likely to be expensive and out of reach for many poor African nations. As such, aid could be directed to providing water security infrastructure and technology.

(b) Health

The UN, amongst other sources, emphasizes how important water is to Africa's success and development: "Africa faces endemic poverty, food insecurity and pervasive underdevelopment, with almost all countries lacking the human, economic and institutional capacities to effectively develop and manage their water resources sustainably."[771] As such, water scarcity is expected to be one of the biggest obstacles for most African countries to meet their Millennium Development Goals (MDGs). Many African populations, especially rural or remote areas, face inadequate access to sanitation, lack of safe drinking water. In addition, "the high incidence of water-related and waterborne disease related to unsanitary conditions is debilitating to African economies and human livelihoods and well-being."[772] Weak state capacity and the inability to provide infrastructure or social services proves to be a major obstacle to many adaptation efforts. Climate change is considered to be a "'threat multiplier', a factor that that exacerbates a wide variety of threats, such as low state capacity, corruption, ethnic tensions, poverty, and inequality."[773] As such, human security issues need to be addressed before they become a larger problem. This section will examine some of the most pressing water insecurity issues that Africa currently faces that will likely be intensified by climate change.

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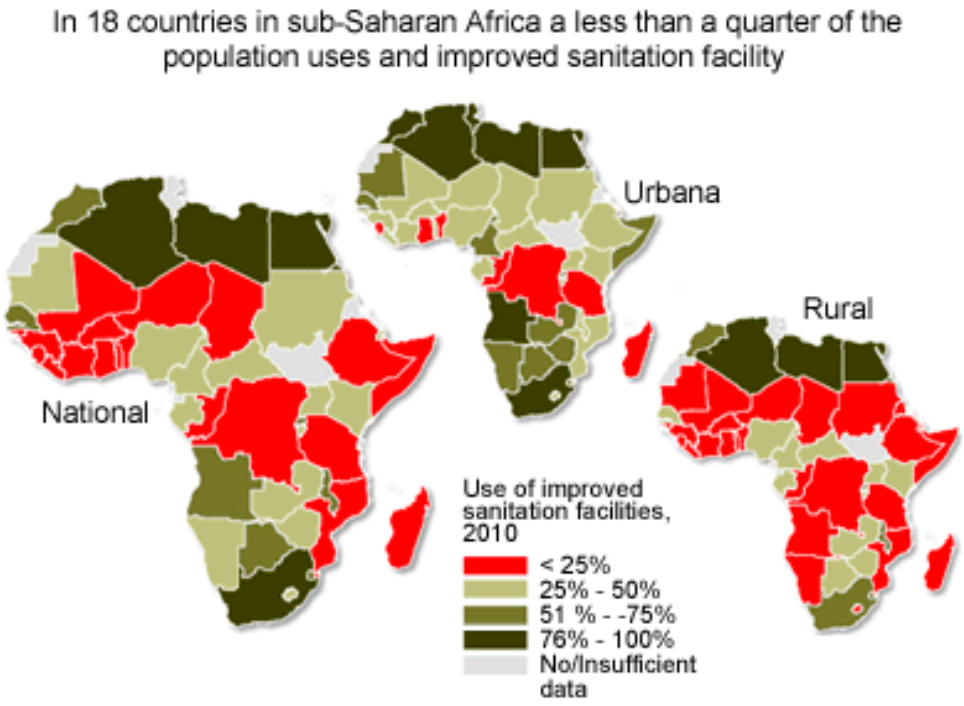
[768] UNEP, "Africa Water Atlas," 208-286.
[769] York, "Drought: How Science Can Help Save Africa".
[770] Ibid.
[771] United Nations, "International Decade for Action 'Water for Life'," https://www.un.org/waterforlifedecade/africa.shtml.
[772] UNEP, "Africa Water Atlas," 129.
[773] Geoffrey D. Dabelko, "Planning for Climate Change: The Security Community's Precautionary Principle," *Climatic Change* 96(1): 15.

Figure 2: A snapshot of Drinking Water and Sanitation in Africa-2012 Update. AMCOW, WHO/UNICEF JMP, 2012.
"International Decade for Action
'Water for Life' 2005-2015." Last updated 2012. http://www.un.org/waterforlifedecade/africa.shtml



MDG section 7C aims to increase the percentage of people with access to drinking water and basic sanitation.[774] Although these targets are being met in many parts of the world, sub-Saharan Africa is falling far behind and stands out as having the least coverage of improved water supply source and drinking water.[775] Regional populations have not benefited from investments in water and sanitation. Only a small fraction of the population enjoys on premise access to piped water connections in these regions. In 2010, only thirty percent of the population in sub-Saharan Africa was covered by improved sanitation facilities and it is estimated that twenty-five percent practice open defecation.[776] Nineteen percent of rural inhabitants in sub-Saharan Africa rely on surface water for everyday use. This is problematic, as the water is not sanitized, often leading to the spread of water borne diseases, especially in children. Access to water and sanitation are lower in rural areas than in urban areas and not surprisingly, access in all areas in correlated with wealth.

[774] "A Snapshot of Drinking Water and Sanitation in Africa," UNICEF and World Health Organization, 2008. 1
[775] "Progress on Drinking Water and Sanitation: 2012 Update," UNICEF and World Health Organization, 2012.
[776] Ibid, 18

In Sub-Saharan Africa, severe water scarcity is balanced with a severe lack of sanitation. Water access has a significant impact on health and can create a cycle of poverty for generations. This is why ensuring peoples' right to water is essential in order to eradicate poverty as water becomes more and more scarce. Water-borne diseases are caused by the ingestion of contaminated water containing human or animal excreta. Sub-Saharan Africa's population suffers markedly from water-borne infections due to a lack of safe and sanitary water supply or disposal options. Diarrhea, caused by these pathogens, is the second leading contributor to the global burden of disease, ahead of heart disease and HIV/AIDS (WHO/UNICEF 2010).[777]Africa accounts for 94% of cholera cases reported to the WHO annually.[778] In Africa, one hundred and fifteen people die every hour from diseases linked to poor sanitation, poor hygiene, and contaminated water.[779] Sanitation will aid in tackling a variety of health issues and reduce child mortality. Access to clean water is essential in order to realize the Millennium Development Goals and break cycles of poverty. Clean water thus constitutes a strong foundation for the development process.

A lack of access to clean water creates a domino effect. As health conditions worsen, available labour is decreased, thereby reducing production, which impedes overall livelihoods. It is estimated that Sub-Saharan Africa loses $28.4 billion annually due to these health costs. Without access to clean water, basic needs cannot be met. People who are weakened by HIV/AIDS are likely to suffer further from the lack of safe water and sanitation, especially since diarrhea and skin diseases are two of the most common infections.[780] Water access also has an impact on gender differences. The United Nations estimates that Sub-Saharan Africa alone loses forty billion hours per year collecting water. This is equivalent to a year's worth of labour by the entire workforce of France.[781] Women and girls in Africa, predominately take on the role of collecting water for the household. Women are increasingly vulnerable and subject to violence when traveling in search of water. They are also unable to pursue other means of livelihood as well as an education. In Malawi, women spend an average of four to five times longer collecting water then men.[782] In Tanzania, a survey found school attendance to be 12% higher for girls in homes located fifteen minutes or less from a water source.[783] In Africa in general, women do 90% of gathering water and wood for the household, as well as food preparation.[784]

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[777] WHO/UNICEF. "A Snapshot of Drinking-water and Sanitation in the MDG region Sub-Saharan Africa." (2010).
[778] WHO. "Diarrheal Diseases," Last updated February 2009, http://www.who.int/vaccine_research/diseases/diarrhoeal/en/index7.html
[779] UNDESA, "International Decade for Action 'Water for Life' 2005-2015," Last updated 2012, http://www.un.org/waterforlifedecade/africa.shtml
[780] Lule JR, Mermin J, Ekwaru JP, Malamba S, Downing R, et al.,"Effect of home-based water chlorination and safe storage on diarrhea among persons with human immunodeficiency virus in Uganda," *The American Journal of Tropical Medicine and Hygene* 73 (2005): 7
[781] The Water Project. "Poverty in Africa Begins with a Lack of Clean Water," Last updated 2013, http://thewaterproject.org/poverty.asp#.UUpmUxxJ6t4
[782] Ibid.
[783] Ibid.
[784] Ibid.

Improving water access as well as sanitation will improve the overall living conditions while providing greater opportunities for education. It is also necessary, however, to address the differences surrounding water access in rural areas as compared to urban.

Both rural and urban populations lack access to clean water. Eighty-eight percent of people, without improved water sources, live in rural areas. Broken down, unsafe, or nonexistent water supplies force people to walk longer in order to collect water for household use. If a village supply fails, women and children will likely have to walk several hours to collect water each day.[785] Rural conditions are much worse than urban, but this does not mean the urban dwellers do not face significant challenges. As people tend to gather densely in urban areas, communities often fail to meet high demands and many are forced to find different sources of water.[786] The urban poor often use inexpensive pit latrines and at the same time draw domestic water from nearby wells. As these areas are often overcrowded, inadequate distances between wells and pit latrines lead to the contamination of these wells and creates vicious poverty cycles.[787] It is necessary to address issues of water access, particularly clean water, in order to break cycles of poverty. Local realities and culture must dictate this process in order to ensure it is sustainable. Technological transfers can aid in this process. One option, for instance, is water harvesting which, consists of collecting rainwater and filtering it. More support needs to be provided for rural communities in order to prevent overcrowding in urban areas as people move in search of work and resources. Education is also another means to spread knowledge on sanitation in order to help prevent outbreaks of aforementioned diseases. The provision of clean water must be a focus of the development community if there is any hope of eradicating poverty.

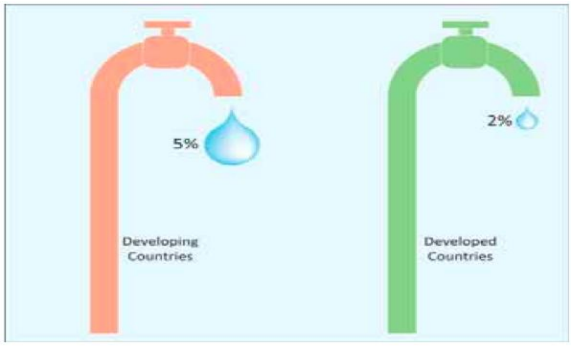

Figure 3.1.2: Percentage loss in GDP due to diseases and productivity losses linked to water and sanitation (Source: UNDP 2006a)

Figure 3: UNEP, "Africa Water Atlas," 126.

[785] Rosen S, Vincent JR., "Household Water Resources and Rural Productivity in Sub-Saharan Africa: A Review of the Evidence," African Economic Policy Discussion Paper 69 (2001): 11

[786] Elizabeth Wambui Kimani Murage, Augustine M. Ngindu. J., "Quality of Water the Slum Dwellers Use: The Case of a Kenyan Slum," *Urban Health* 84 (2007): 832.

[787] Murage and Ngindu, 832.

(c) Governance and Management

Much of Africa is extremely vulnerable to disasters because governments lack the capacity to protect and secure livelihoods. Disasters reported across the region have increased, with droughts and floods affecting the most people.[788] These extreme events are forecasted to increase in frequency and severity as a consequence of climate change. The Global Facility for Disaster Reduction and Recover is a partnership of countries and organizations "committed to helping developing countries reduce their vulnerability to natural hazards and adapt to climate change."[789] When disasters occur, most governments are dependent to some degree on assistance from international organizations to assess damages and losses and provide relief, recovery, and reconstruction efforts.

For communities that depend on rain-fed agriculture, as is the case in many countries in Africa, especially among the poor, the impacts of natural disasters are especially severe. The "disaster risk-poverty nexus" refers to the limited ability of impoverished populations to recover after extreme events.[790] In these regions infrastructure that is crucial for relief delivery, such as schools, hospitals and roads, need to be properly maintained to ensure an effective response. Following the 2005 World Disaster Reduction Conference the Hyogo Framework for Action (HFA) was created, which outlines procedures and methods that will reduce vulnerability to natural hazards.[791] African ministers adopted and endorsed the HFA program but implementation of disaster risk reduction strategies has not yet been fulfilled in many countries that lack commitment from their governments. Early Warning, Early Action strategy was used by the International Federation of Red Cross in West Africa to enhance preparedness and resilience to floods. By evacuating communities, training volunteers and setting up relief stations throughout the region the response was quicker and more effective.[792]

Governance and resource management on a domestic level and inter-state level is extremely important and will be very challenging for Africa. In July 2011, Ban Ki-Moon said:

> Competition between communities and countries for scarce resources, especially water, is increasing, exacerbating old security dilemmas and creating new ones, while environmental refugees are reshaping the human geography on the planet, a trend that will only increase as deserts advance, forests are felled and sea levels rise.[793]

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[788] "Report on the Status of Disaster Risk Reduction in Sub-Saharan Africa." The World Bank, 2010.
[789] The Global Facility for Disaster Reduction and Recovery. https://www.gfdrr.org/node/1
[790] Report on the Status of Disaster Risk Reduction in Sub-Saharan Africa." The World Bank, 2010.
[791] United Nations Office of Disaster Reduction, *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters* (Geneva: International Strategy for Disaster Reduction, 2007).
[792] Lisette Martine Braman, Maarten Krispijn van Aalst, Simon J. Mason, Pablo Suarez, Youcef Ait-Chellouche and Arame Tall "Climate forecasts in disaster management: Red Cross flood operations in West Africa, 2008" *Disasters* 37.1: 2013, 144-164
[793] UNEP, "Livelihood Security: Climate Change, Migration and Conflict in the Sahel," 7.

As noted previously in the section on agriculture, many African countries are heavily reliant on water dependent agriculture. It makes up a significant portion of their GDP, "national food needs, employment and export revenue."[794] This is particularly true in West Africa and the Sahel region. The "competition for access to and control of these resources remains a real issue, which is at the root of the recurrent conflicts that threaten social peace and hold back development… highlighting the disruption of the ecological, social and economic balance."[795] The domestic governance of water and water usage is predicted to be another key challenge for many African nations.

Currently, many areas are governed by "complex natural resource systems that combine customary structure and laws inherited from the colonial era, as well as reforms" taken by governments in the 1980s-1990s.[796] This created a general disconnect, decreased the capacity for reform, furthered environmental degradation, and inhibited effective governance.[797] This is particularly true for land possession, as previously discussed in the agriculture section. To make matters worse, many weak or failing states in Africa lack appropriate dispute resolution systems. The widening gap between rich and poor is a concern because elites "are organized in such a way as to give themselves privileged access and control over resources and opportunities."[798] This leads some scholars to believe that the chances resource capture and conflict are increased by the consequences of climate change.

Effective water governance is necessary in Sub-Saharan Africa in order to improve living conditions on the ground. Water governance at the state level can aid in improving issues of access at the local level, including local management and sanitation. In Africa, seventy-five percent of the region's surface water is shared among two or more countries.[799] The principle surface water resources lie in its many international river basins. There are seventeen major river basins which are integral to the preservation of local livelihoods.[800] Water governance is a means to sustain state cooperation but, also has the potential to inspire conflict. Conflict over water, although minimal, can occur indirectly. As the concentration of runoff generated in the upper stream reaches the river systems, the downstream riparian, often with a dry climate, tend to be very much affected by the actions of the upstream states.[801] This interconnectedness and interdependency has the potential to inspire cooperation but, also competition for resources. When the downstream country is economically

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[794] Ibid, 5.
[795] Ibid.
[796] UNEP, "Livelihood Security: Climate Change, Migration and Conflict in the Sahel," 20.
[797] Ibid.
[798] Mohamed Hamza and Cosmin Corenda, *Climate Change and Fragile States: Rethinking Adaptation*, (Bonn: United Nations University Institute for Environment and Human Security, 2012), 17.
[799] Tetra Tech, "Southern Africa: Integrated River Basin Management Activity in the Okavango Basin," Last updated 2013, http://www.tetratechintdev.com/intdev/index.php?option=com_k2&view=item&id=214%3Asouthern-africa-integrated-river-basin-management-activity-in-the-okavango-basin&Itemid=61&lang=fr
[800] Robert Rangeley, Bocar M. Thiam, Randolph A. Andersen, and Colin A. Lyle, "International River Basin Management in Sub-Saharan Africa," World Bank Technical Paper 250 (1994): 3.
[801] Rangeley et. al., 3.

"poorer" or politically and militarily "weaker" than their upstream neighbours, significant tension between states ensues.[802] These countries often have markedly different levels of need for water and wide socioeconomic disparities.[803] This competition between upstream and downstream countries poses the greatest potential for conflict over water in Africa.

Resource distribution is an area of contention in Africa as livelihoods are highly resource-dependent due to the large agricultural sector. Resource management is necessary in order to pursue a more equitable system of distribution as well as sustainable development. Effective water governance is needed in countries like Egypt, Botswana, and Niger, which respectively obtain 97%, 94%, and 68% of their total freshwater from sources in neighbouring states.[804] The potential for conflict largely remains an unknown in Africa and will depend on both local and state-level responses to increased water scarcity. Historically, there is evidence both supporting and opposing the notion of increased potential for conflict. The Congo River basin, for example, has no established basin-wide cooperative framework for management and development of the basin. Conflicts among member states has occurred due to resource competition as states in the region suffer from weak economies, water security issues, a history of struggle, and a lack of sound basin data and capacity building.[805] Another example is the management of the Incomati and Maputo rivers which touches Mozambique, South Africa, and Swaziland. The Tripartite Permanent Technical Committee (TPTC) was established in 1983 and is a joint body for cooperation in charge of advising, contracting parties on technical, legal, administrative, and other reasonable measures related to management and development.[806]There have, however, been some disputes as each state is at very different levels of development, although it should be noted that direct conflict has been avoided.[807]

Water governance has also proven to be a means of cooperation over resources and border disputes between states. This is evident with the management of the Lake Chad river basin which includes Algeria, Cameroon, Central African Republic, Chad, Libya, Niger, Nigeria, and Sudan.[808] In the 1970s and 1980s, the Lake Chad Basin Commission helped settle border disputes with Nigeria and Chad and has, historically, helped promote cooperation.[809] Decreasing rainfall, drought and desertification, environmental degradation, increasing water demand, high poverty levels, institutional capacity building, and funding problems have, however, impeded states' capacity to ensure cooperative relations. Water governance at the state level can be a means to pursue cooperation and tackle local-level issues of poverty.

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[802] Peter J. Ashton, "Avoiding Conflicts over Africa's Water Resources," *Ambio* 31.3 (2002): 239.
[803] Ashton, 236.
[804] Ibid, 240.
[805] "Source Book: On Africa's River Basin Organization," January 2007: 13, http://www.inbo-news.org/IMG/pdf/AWRB_Source_Book-2.pdf
[806] Ibid, 19.
[807] Ibid, 21.
[808] Ibid, 33.
[809] Ibid, 35.

However, as the impacts of climate change intensify, greater stress will be placed on states and the potential for conflict will increase. Greater coordination with local actors is necessary in order to develop effective adaptation measures to relieve local resource scarcities, which will also reduce the potential for violent competition over resources. Water governance should be regarded as a means to cooperation at all levels of governing, and coordination among states will decrease the strain of resource scarcities the region is currently facing and will face in the future.

For further information on Africa and Water Scarcity: United Nations Environment Programme (UNEP), "Africa Water Atlas," Division of Early Warning and Assessment (2010). This is a comprehensive study on the issues Africa faces and individual country analyses.

(2) CANADA AND AFRICA

In a traditional security sense, Canada has relatively little to do with Africa. Canada is not a major trading partner with Africa, the repercussive effects will likely be minimal, and so far there has yet to be a major security issue in a traditional sense. However, in light of recent events like the Arab Spring, it is clear that the world is becoming smaller, more interconnected, and traditional security has a different place in international relations. Human security and alternative definitions of security are becoming increasingly prominent. Based on the normative approach outlined in the 'Canadian Interests' section and 'water as a right', it is clear that Canada will stand in a position to help Africa.

Many different leading nations in the world are beginning to revise their policies towards Africa. The most prominent example is "the Obama administration in the United States… The US, the EU, China, India, [and] Brazil have already adjusted their vision of Africa and are seeking to intensify their political, economic, and diplomatic engagement."[810] If the trend is towards increasing involvement in Africa, it may be wise for Canada to follow suit.

Canada's role in Africa has been on a gradual decline under the Harper government. In 2007 the Prime Minister's address to the council on Foreign Relations signaled changes were imminent to the government's foreign aid policy.[811] This began a new tilt towards Latin America, and a shift away from development assistance and Africa.[812] In 2009, the government announced a more strategic, security-oriented approach to aid policy. Africa was the "big loser" in terms of the new countries of focus, dropping eight of the fourteen African states on the previous list.[813] These shifts reduced the concentration of bilateral aid resources in countries experiencing the highest levels of poverty. Aid was securitized and to be used to promote liberal

[810] Canadian International Council, "Positioning Canada for the Africa of 2015".
[811] David Black, "Out of Africa? The Harper Government's New 'Tilt' in the Developing World," *Canadian Foreign Policy Journal* 15 (2009): 43 (41-56)
[812] Ibid, 41.
[813] Ibid, 43.

democracy.[814] Interests in Africa have shifted towards extractive industry investment and activity; however Canada has largely overlooked the prospect of Africa as a growing market.[815] In 2009, the Harper government also announced the closure of at least four diplomatic missions in Africa, further reducing what is already the smallest number of African embassies among all G8 countries, with the exception of Japan.[816] This is extremely problematic for Africa and for Canada. With the impacts of climate change intensifying, affecting livelihoods and the perpetuation of poverty, Canadian support for African development is needed now more than ever.

Under the Conservative government, there is deep skepticism surrounding the effectiveness of aid and its contribution to bloated government spending. This neglects not only the moral role of aid, but also the strategic one. Their approach to Africa neglects the fact that commercial exploitation of the continent's abundant resource riches will not be pursuable in conditions of political, social, and economic instability. [817] Before significant economic benefits can be realized from partnerships with African countries, current needs must be dealt with. This must be motivated by recipient-based needs as well as around poverty alleviation. This is also of national interest because Canada's greatest contributions on the world stage have come from its stature as a middle power.[818] In 2010, CIDA's policy was organized around three themes: first, strengthening accountability for, and effectiveness of, foreign assistance; second, improving the health of children under the age of 5, and strengthening food security initiatives; and third, redoubling efforts to achieve the Millennium Development Goals.[819] These aims may be inhibited by the government's recent merging of CIDA with the Department of Foreign Affairs and International Trade (DFAIT).[820] This will further commercialize Canada's foreign aid and prevent CIDA from addressing human security concerns. Poverty alleviation cannot be effectively pursued if it is subordinated to commercial interest. In order to adequately deal with the stress of climate change, local needs must guide foreign aid. This shift in policy is preventing Africa from breaking out of the poverty trap. A developed and stable Africa is in Canada's interest because the government and independent Canadian organizations have invested billions into the continent. It has been demonstrated that water security is under serious threat in Africa, with many countries currently water insecure. So the Canadian government's recent decision to abandon the United Nations Convention to Combat Desertification (UNCCD) is highly problematic. Drought is a primary concern in Africa, and aiding in the construction of adequate adaptation policies needs to be a priority of development organizations. The issue of encroaching deserts has become urgent because of

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[814] Ibid, 44.
[815] Dialo Lamine, and Izarali Raymond, "Why Canada Needs a Focused Foreign Policy towards Africa in the Twenty-First Century," *Africa Review* 2.2 (2010): 201.
[816] Black, 45.
[817] Lamine, 210.
[818] Ibid, 213.
[819] Ibid, 204.
[820] Plan Aid, "Plan Canada's statement: Federal budget merges CIDA into Foreign Affairs," (2013), http://plancanada.ca/cida-merges-with-foreign-affairs.

renewed droughts that have plunged millions into poverty in Africa's Sahel belt last year and in East Africa the year before.[821] Desertification as a result of climate change and the loss of biodiversity were identified as the greatest challenges to sustainable development during the 1992 Rio Earth Summit, and the impacts have only intensified since.[822] If the effects of drought are not dealt with, millions will continue to die and resources will be destroyed. The effects of climate change in Africa are problematic from a human security perspective, but also in terms of national security. Instability in a region affects the international community. Climate change has transnational implications, meaning all states must be involved in managing it.

Canada's current foreign policy is what some call 'The Harper Doctrine'. As one commentator noted, "[t]he Harper Doctrine permits real money to be spent on foreign aid, but that aid must mirror core conservative values - so no funding for abortion or for aid groups seen as soft on Israel."[823] The policy is more militant, which explains Canadian military involvement in Libya and Mali. Stephen Harper summed up his foreign policy when he said, "We know where our interests lie and who our friends are… and we take strong, principled positions in our dealings with other nations, whether popular or not."[824] Recent actions towards foreign aid and Africa clearly illustrate that Africa is currently not in Canada's interests. These recent actions further cast doubt on active Canadian participation in alleviating water insecurity. In 2011, Africa suffered from a severe drought and Canada ended u committing millions in emergency aid, sending $57.5 million to the Sahel region, while "ordinary Canadians donated another $7-million. But these kinds of emergency aid donations might be unnecessary if scientists could find ways to prevent droughts in Africa – a key goal of a United Nations convention on desertification and drought, from which the Canadian government has now withdrawn."[825]

There is clearly a disjuncture in Canada's recent policy changes toward Africa, cutting relatively cheap long-term investments that deal with underlying instabilities and lack of development, while failing to recognize that short-term military interventions are far costlier. Canada was an active supporter of the UNCCD convention.[826] The cost was relatively low, with Canada providing a $283,000 grant to support the convention from 2010 to 2012.[827] Canadian support of French military

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[821] The Canadian Press, "Harper government quietly leaving UN droughts and deserts convention," (2013), http://www2.macleans.ca/2013/03/28/harper-government-quietly-leaving-un-droughts-and-deserts-convention/
[822] The Canadian Press, 2013.
[823] John Ibbitson, "The Harper Doctrine: Conservative Foreign Policy in Black and White," The Globe and Mail (September 10, 2012): http://www.theglobeandmail.com/news/politics/ottawa-notebook/the-harper-doctrine-conservative-foreign-policy-in-black-and-white/article615115/
[824] Ibid.
[825] Geoffrey York, "Drought: How Science Can Help Save Africa," *The Globe and Mail*, March 29, 2013.
[826] The Canadian Press, "Canada Quietly Pulls Out of the UN Anti-droughts Convention," CBC News (March 27, 2013): http://www.cbc.ca/news/canada/story/2013/03/27/un-droughts-deserts-convention-canada.html.
[827] Ibid.

actions in Mali, by contrast, is costing Canadians approximately $18.6 million.[828] As outlined earlier in this section, taking an interest and assisting Africa to achieve water security does not have to be selfless. There can be scenarios where Canadian businesses can help achieve sustainable water-use projects in Africa while benefiting themselves, such as recent investments by Ottawa-based Cowater International in water infrastructure projects in now peaceful Angola. [829] However, these investments will be much more difficult if Canada refuses to play its part in helping to deal with the long-term development and climate change challenges in Africa.

[828] James Cudmore, "Cost of Canada's C-17 in Mali $18.6M, General says," CBC News (January 31, 2013): http://www.cbc.ca/news/politics/story/2013/01/31/pol-mali-foriegn-affairs-committee-briefing.html.
[829] The Angolan government has selected "Cowater International Inc. to develop a national strategy for investment in water supply and sanitation for its rural areas" in Angola, and the company has also been awarded contracts to supply water and sanitation services in Mozambique's Inhambane province. Sheldon Gordon, "*Into Africa: Canadian Firms Jump on Opportunity,"* The Globe and Mail, (September 6, 2012), http://www.theglobeandmail.com/report-on-business/small-business/sb-growth/going-global/into-africa-canadian-firms-jump-on-opportunity/article535446/.

Conclusions

Climate change stands to have immense and significant effects on global water security as it will negatively impact water quantity and quality. This report has addressed the complexity of the water security issues from both a Canadian and global perspective by analyzing the consequences that climate change will have on water in North America, Africa, Middle East, Latin America, and South Asia. In doing so, the report has illustrated that Canada and the international community will need to implement mitigation and adaptation policies in order to deal with the issue of water security, as a failure to do so will likely have a profound impact on human and national security.

The analysis that has been conducted on these regions illustrates major themes that are closely tied with the issue of water security, namely: food security, energy security, economic development and sustainability, health, migration and conflict. While analyzing water's relationship to these variables has been extremely useful for teasing out the implications that water security will have at the national levels, the report acknowledges that these variables will also interact with one another and that a shock or dislocation in one sector will affect many additional sectors because of social and physical interdependencies. This may have further and unforeseen consequences on communities, socio-ecologic systems, and regions. As a result, this report suggests that extensive micro level and cross-sectoral analysis be done in order to give greater detail on context specific vulnerabilities.

Throughout the report it was emphasized that individuals, communities, nations and regions must introduce significant changes in order to reduce the negative impacts that climate change will have on water security. One major theme in the report was to decrease regional risks and vulnerabilities by increasing the adaptive capabilities of states. Although specific policy suggestions were made regarding possible ways in which this could be done, issues of water governance and institution strengthening and building applied to almost every region. It will also be important that the international community ensures that high-risk, low-capacity countries have access to leading-edge scientific information and technology that can minimize the effects of climate change. Obstacles to adaptation such as financing issues, a lack of coordination across different jurisdictions, divergent perceptions regarding climate change, and a general unwillingness to address long-term changes must be tackled by the international community head on.

Although climate change in Canada will not significantly impact our availability of water resources, it will be important for Canada to take a leading role in the international community due to its abundant water resources. The regional analyses presented in this report have highlighted areas where Canada has current interests and where future interests may be, given that these areas are at a high risk and have low adaptive capacity. This is due to the fact that water insecurity in other

regions will impact Canadian foreign policy interests and may jeopardize Canada's national security in the process. There are many suggestions in the report where Canada can act unilaterally, bilaterally, through diplomatic negotiations, or by encouraging cooperation and participation in multilateral organizations. The route that the Canadian federal government decides to take in tackling this objective will be contingent on several factors. The recommendations made in this report provide a strong foundation for future policy makers to formulate strategies to both mitigate and adapt to the onset of water availability pursuant of climate change.

APPENDIX A: CANADIAN FOREIGN POLICY

CANADIAN FOREIGN POLICY AND NATIONAL INTERESTS

In order to identify specific regions and countries where Canadian interests are at risk, or where opportunities may arise as a result of the physical effects of climate change, it is necessary to define what the 'national interest' is and explore how it is identified.

The national interest is a controversial notion for academics because it usually denotes a general public interest; however, what constitutes the 'public interest' is, in practice, up for debate.[830] Considering the enormous diversity among groups in modern society, it is easy to understand that an equally diverse number of interpretations exist of what the national interest should be. A statist approach emphasizes the role of the state or government as the main source of policy, and therefore the entity that autonomously defines the national interest.[831] Thus, even within the pluralistic reality of modern states, the statist would argue that it is necessary for an autonomous actor (the state) to determine the interests of society as a whole and not be swayed by the interests of any individual group.[832] However, it is difficult to understand how or why a state would always act strictly in the public interest because, after all, governments are composed of individuals with their own interests and who might owe allegiances to interest groups. One way out of the predicament of defining or determining national interest is to suggest that the national interest is a normative concept, a prescription for "what ought to be" rather than just "what is."[833] As a normative concept, the national interest can operate against the possibility of corruption and can serve as a forum for a public policy debate on the just purposes of state authority.[834] The national interest can also be identified inductively by examining the government's preferences over time. An inductive method seeks to define the national interest based on three components: they are objectives related to general societal goals, they persist over time, and they have a consistent ranking of importance.[835]

To varying degrees, each of these theoretical bases for determining the national interest have been instrumental in determining Canadian national interests during the past twenty years. The following section will provide a brief history of Canadian foreign policy within the last twenty years and will demonstrate how different Canadian governments have identified the national interest normatively, inductively, and autonomously.

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[830]Steven Holloway, *Canadian Foreign Policy: Defining the National Interest* (Peterborough, ON: Broadview Press, 2006), 9.
[831] For a more detailed explanation of *statism* see: Holloway, 7-10.
[832] Holloway, 9.
[833] Ibid., 11.
[834] Ibid.
[835] Ibid., 12.

Since the end of the Cold War, the trajectory of Canada's foreign policy has changed several times. Two shifts in foreign policy can be identified; one in human security, and another in Canada's relationship with the United States. These two areas of foreign policy demonstrate Canada's shift away from human security initiatives, and the complex relationship it shares with its closest ally, the United States. From 1993 to 2003 under former Prime Minister Jean Chretien's liberal government, Canada made human security a priority of its foreign policy.[836] Lloyd Axworthy, Minister of Foreign Affairs from 1996 to2000, heavily influenced Canadian foreign policy through the 'Axworthy Doctrine.' The Doctrine sought "security for all people everywhere," and served as the basis for Canadian foreign policy until 2000.[837] This approach was illustrated in 1998 when Canada and Norway negotiated the Lysoen Declaration in an attempt to bring international attention to human security.[838] However, towards the end of Chretien's liberal government, Canada's human security initiatives were reduced, demonstrated by both peacekeeping and foreign aid efforts. In the 1970s, Canada was the largest peacekeeping force. Yet in 2001, Canada was ranked 32nd in the world in peacekeeping size. [839] From 2003 to 2006, under former Prime Minister Paul Martin's liberal government, Canada based its foreign policy on middle power internationalism rather than the Axworthy Doctrine, thereby altering Canada's approach to human security. Middle power internationalism promotes human security as being guided by state interests, and focuses on hard power rather than soft power.[840] This approach resulted in a further reduction of Canada's peacekeeping forces under Martin. As of August 2006, Canada was ranked 55thin the world.[841] The decreased peacekeeping force is a trend that has continued under Prime Minister Stephen Harper's conservative government. Canada, as of March 2012, was ranked 53rd in the world United Nations' peacekeeping operations.[842]

A shift in priorities is also evident regarding Canada's foreign aid allocation and developmental assistance. Canada's foreign aid under Chretien was reduced from 0.44 percent of the Gross National Product (GNP) in 1993-1994 to 0.25 percent.[843] This trend has been continued under Harper's conservative government,

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[836] Prosper Bernard, "Canada and Human Security: From the Axworthy Doctrine to Middle Power Internationalism," *American Review of Canadian Studies* 36,2 (2006): 233, http://web.ebscohost.com.proxy2.lib.uwo.ca/ehost/detail?vid=3&sid=0f1e3afc-a2ef-4c49-8f55-20ab62267008%40sessionmgr110&hid=113&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=a9h&AN=22533693 . Human security is the attempt by governmental and non-governmental actors to improve human protection and well-being.

[837] Ibid, 256.

[838] Ibid, 236.

[839] Ibid, 237.

[840] Prosper Bernard,"Canada and Human Security: From the Axworthy Dcotrine to Middle Power Internationalism, " 246.

[841] United Nations Association in Canada, *Peace and Security*, http://www.unac.org/peacekeeping/en/un-peacekeeping/canada-and-un-peacekeeping/

[842]United Nations, *Ranking of Military and Police Contributions to UN Operations,* http://www.un.org/en/peacekeeping/contributors/2012/March12_2.pdf.

[843] Kimberly Marten, "Lending Forces: Canada's Military Peacekeeping," in *The Handbook of Canadian Foreign Policy*, Patrick James, Nelson Michaud and Marc O'Reilly eds., (Lexington Books: Oxford, 2006), 170.

as Canada's foreign aid has been well below the goal established by the United Nations that all countries will allocate 0.7 percent of its GDP to foreign aid.[844] In terms of developmental assistance, Canada has historically been one of the top ten countries on the United Nations' human development index. Throughout the 1990s, under both Brian Mulroney and Jean Chretien, Canada was the number one country in developmental assistance.[845] In 2011, Canada ranked sixth in developmental assistance and has by now slipped to eleventh, [846]demonstrating the shift in Canada's priorities regarding foreign aid and developmental assistance.

Another important issue that should be discussed is Canada's immigration and refugee policy. Since 2001, following the terrorist attacks in the United States, Canada sought to increase the security of its border. In doing so, Canada has adopted stringent immigration regulations, impacting those who require asylum or seek entrance into Canada. In 2004 under Martin's liberal government, Canada and the United States signed the Safe Third Country Agreement (STCA). The STCA is meant to both further secure the Canada-U.S. border, while decreasing the number of asylum claims Canada receives by requiring asylum seekers who arrive at a port of entry along the Canada-U.S. border to apply for asylum in the first country they land in.[847] The mindset of the legislation is that both countries are a 'safe third country' as they are signatories of the Convention Relating to the Status of Refugees, and thus have a fair asylum system. The STCA also requires that a refugee will be returned to the country they first landed in, and that the refugee claim will be processed in the country that admits the refugee.[848] In 2012, the current government adopted Bill C-31, the Protecting Canada's Immigration System Act. This Bill also identifies 'safe countries,' and requires claimants of unsafe countries to obtain visas. Citizenship and Immigration Minister Jason Kenney has argued that this will protect Canadian national security by preventing criminals and dangerous individuals from entering Canada.[849] Furthermore, countries with a high number of asylum claims and with unreliable documents, such as Mexico, have had visa requirements placed on them, making it more difficult for refugees from these countries to gain access to Canada.[850]

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[844] Patrick James et al., "Canadian Foreign Policy in a New Millennium: The Search for Understanding," in *The Handbook of Canadian Foreign Policy*, ed. Patrick James, Nelson Michaud and Marc O'Reilly (Lexington Books: Oxford 2006), 14.

[845] Campbell Clark, "Canada Falls Out of Top 10 in UN's Human Development Index," *The Globe and Mail,* March 14, 2013, http://www.theglobeandmail.com/news/national/canada-falls-out-of-top-10-in-uns-human-development-index/article9758218/?cmpid=rss1.

[846] Ibid.

[847] Denis Coderre, to Canadian News Editors (January 10, 2003). http://www.cic.gc.ca/english/press/letters/letter-terror.html.

[848] Audrey Macklin, "Disappearing Refugees: Reflections on the Canada-US Safe Third Country Agreement," *Columbia Human Rights Law Review* 36, (2005): 371, .

[849] Government of Canada, Citizenship and Immigration, *Making Canada's Asylum System Faster and Fairer* (Ottawa, ON, 2012) http://www.cic.gc.ca/english/department/media/releases/2012/2012-11-30.asp.

[850] The West Block on Global, "Immigration Minister Jason Kenney Discusses New Proposed Refugee Laws," *YouTube video,* February 20, 2012, http://www.youtube.com/watch?v=OE3YCax8qAY.

Canada's relationship with the U.S represents another shift in Canadian foreign policy. Scholar Denis Stairs described the Canada-US dynamic by saying "…the only real imperative in Canadian foreign policy is Canada's relationship with the U.S."[851] From 1984 to1993, Canada and the U.S shared a close relationship. Canada joined the Free Trade Agreement with the U.S in 1988, leading to the creation of the North American Free Trade Agreement (NAFTA) in 1994. However, between 1993 and 2003, Chrétien's liberal government focused primarily on internationalism, with the result being that Canadian and American foreign policy diverged. While Canada did sign NAFTA under Chrétien's liberal government, Chrétien's relationship with George W. Bush was difficult, particularly after Chrétien's government refused to send the Canadian Armed Forces to Iraq. Paul Martin's liberal government sought to improve Canada-U.S. relations, yet the trend established by Chrétien continued under Martin's leadership. Under Martin's government, Canada refused to join the U.S. Ballistic Missile Defense (BMD) program after originally committing to the project, which negatively impacted relations.[852] Under its current conservative government, Canada appears to have repaired its relations with the U.S. Several bilateral agreements between the two nations, including the Beyond the Border security initiative[853] and Perimeter Security and Economic Competitiveness Action Plan, have been signed in recent years. [854] Also, some of Canada's current foreign policy objectives, such as Canada's increased support for Israel, are supportive of American foreign policy and interests.

Canada's domestic policies and international position with respect to climate change are constantly evolving. However, one thing that remains consistent is the federal government's tendency to use rhetoric suggesting aggressive action while failing to implement the necessary regulations. Canada's historical international position has been one of multilateral engagement, beginning with its decision to host a major conference, 'The Changing Atmosphere: Implications for Global Security,' in Toronto in June 1988.[855] Canada is also a signatory to both major treaties on climate change, the United Nations Framework Convention on Climate Change, 1992 (UNFCCC) and the Kyoto Protocol, 1997 (KP). The latter committed Canada to greenhouse gas reductions of six percent below 1990 levels in the 2008-2012 period, a goal that the country ultimately failed to achieve, with its emissions growing 17.4

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[851] Canadian Defence and Foreign Affairs Institute, *In the National Interest: Canadian-Foreign Policy in an Insecure World*, by Denis Stairs et al., http://www.cdfai.org/PDF/In%20The%20National%20Interest%20-%20English.pdf viii.

[852] Kim Nossal et al., "The Prime Minister and International Policy," in *International Policy and Politics in Canada,* Kim Nossal, Stephanie Roussel, Stephane Paquin eds. (Toronto: Pearson Canada, 2011), 171.

[853] Prime Minister of Canada, *Beyond the Border: A Shared Vision for Perimeter Security and Economic Competitiveness*, http://pm.gc.ca/eng/media.asp?id=3938. The Beyond the Border agreement is an attempt by both Canada and the U.S. to secure Canada U.S. border while maintain economic ties.

[854] Government of Canada, Citizenship and Immigration, *Backgrounder, Immigration Information Sharing Treaty*. This agreement will require further cooperation between U.S. and Canada immigration officials, as it promotes information-sharing regarding asylum seekers.

[855] Paul R. Samson, "Canadian Circumstances: The Evolution of Canada's Climate Change Policy," *Energy and Environment* 12, no. 3 (2001), 201.

percent relative to 1990 levels.[856] This occurred for a variety of reasons, perhaps the most significant of which was that the federal government's official strategy, the *Government of Canada Action Plan 2000 on Climate Change,* covered only one third of its target and included no legal mechanisms to ensure compliance.[857] However, another significant obstacle exists in the need for collaboration between the federal government and its provincial counterparts. This is because the federal government has the constitutional authority to negotiate international climate change agreements, while provinces have power over the distribution and use of energy and natural resources, both of which are critical to climate change mitigation.[858]

Following the December 2011 Climate Change Conference in Durban, South Africa, when it had become clear that Canada would not meet its Kyoto target, the federal government chose to withdraw Canada from the Protocol. This decision has been heavily criticized as destructive to international climate governance, with one Canadian group, Climate Action Network Canada, labeling it a "total abdication of our responsibilities."[859] However, despite opposition to Canada's withdrawal, this move was in line with the Harper government's longstanding policy to coordinate Canadian climate change policy and other environmental regulations with those of the United States. This position has been justified by the notion that "Canada's economy is integrated with the United States' to the point where it makes absolutely no sense to proceed without aligning a range of principles, policies, regulations and standards."[860] In addition to withdrawing from the KP to match American obligations, Canada has also set its current emissions reduction target and approach to equal that of the United States. This includes a commitment to reduce greenhouse gas emissions to seventeen percent below 2005 levels by 2020 by imposing regulations on a sector-by-sector basis.[861] This approach includes recently announced emission standards for cars and light trucks, as well as for heavy-duty vehicles that are aligned with standards already adopted by the United States.[862] Canada is also a member of the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants that will address short-term climate change, while also promoting food

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[856] UNFCCC, *Changes in GHG emissions excluding LULUCF (%)*,http://unfccc.int/files/inc/graphics/image/jpeg/ghg_total_excl_2012c.jpg (accessed March 19, 2013). It should be noted that official emissions data is currently only available for the 1990-2010 period from the UNFCCC. However, the trajectory of Canadian emissions at this point indicates the inevitability of Canada's failure to meet its commitments.

[857] Canada, *Government of Canada Action Plan 2000 on Climate Change* (Ottawa, ON, 2000), http://publications.gc.ca/collections/Collection/M22-135-2000E.pdf.

[858] John Drexhage and Deborah Murphy, *Climate Change and Foreign Policy in Canada: Intersection and Influence* (Toronto, Canada: Canadian International Council, 2010), 13.

[859] Alex Scott, "Canada Withdraws from Kyoto Protocol," *Chemical Week* 173, no. 31 (Dec. 2011): 12, http://search.proquest.com/docview/1013533707/fulltextPDF?accountid=15115 (accessed March 19, 2013).

[860] "Canada's Continental Action," Government of Canada, last modified February 25, 2013. http://climatechange.gc.ca/default.asp?lang=En&n=A4F03CA6-1.

[861] Ibid.

[862] "Canada Continues to Align Greenhouse Gas Emissions Measures with the United States," Government of Canada, last modified March 18, 2013. http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=3FC39747-ABF2-470A-A99E-48CA2B881E97.

and energy security.[863] This coalition includes the United States and several other states, which further emphasizes Canada's desire to align its own policies with those of its largest trading partner.

Based on the factual and theoretical bases discussed above, we believe that it is best to adopt a normative approach that focuses on what Canada 'ought to do' in its actions around the globe for the purposes of this study. This means that foreign policy should be determined by the values that transcend Canadian society and which have persisted over time and that these should reflect the personal values of a large portion of the Canadian population in order to satisfy our democratic principles. This is not to say that Canadian foreign policy should not be influenced by the country's strategic interests, but rather that we should act in areas where our values and interests coincide. Thus, the values that ought to provide the foundation from which Canadian foreign policy decisions are made should include: respect for the rule of law, democracy, economic security, equity, and environmental sustainability.

[863] "Climate and Clean Air Coalition (CCAC) to Reduce Short-Lived Climate Pollutants (SLCPs)," Government of Canada, last modified August 16, 2013. http://climatechange.gc.ca/default.asp?lang=En&n=7F771E4A-1

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