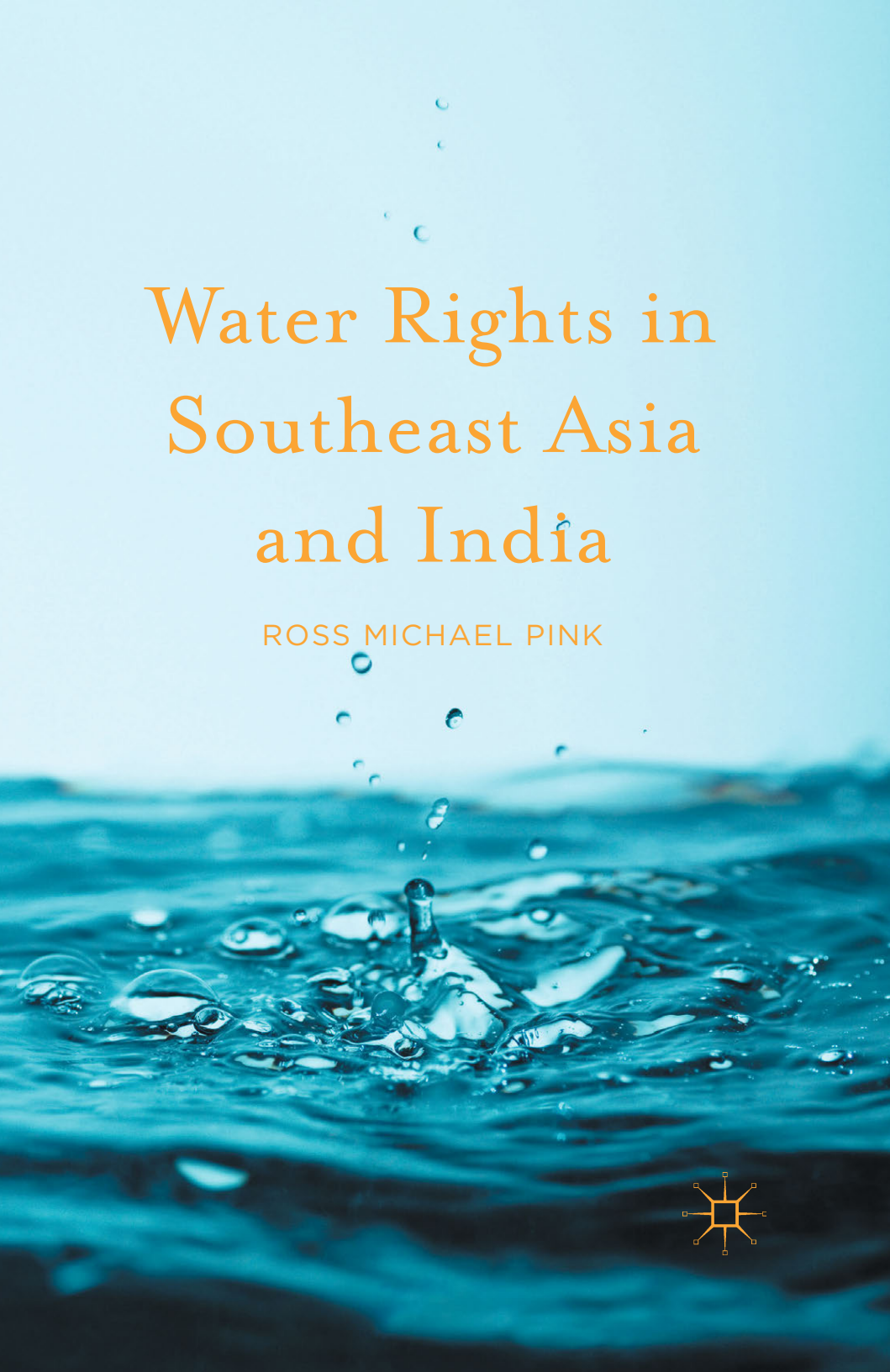
Water Rights in Southeast Asia and India

ROSS MICHAEL PINK



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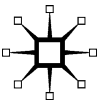

WATER RIGHTS IN SOUTHEAST ASIA AND INDIA

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To my children, Jordan and Olivia,
for their inspiration and idealism

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Introduction

> The noblest of the elements is water.
>
> —Pindar, 476 BC

Water is the most precious resource on our planet. For the greater part of human history, water has been in abundant supply in most regions of the world and therefore an accessible resource for the vast majority of humanity. Sadly, this is no longer the case. In 2015, according to the United Nations, close to 800 million people have no access to safe, clean water sources and the number continues to climb. It is a crisis propelled by two factors: (1) surging population in the developing world and (2) water depletion and/or contamination caused by global warming and rampant unchecked pollution. Today, global population stands at approximately 7.1 billion and is projected to reach 9.7 billion by 2050. The current level of water insecurity that affects nearly 800 million people will be exacerbated in future decades by growing population, pollution, and climate change.

Diseases caused by contaminated water and unhealthy sanitation practices cause over 10,000 deaths per day, including 5000 children under the age of five. Unclean, unsafe water and poor sanitation are not only the greatest human rights crises facing the world today but also the gravest health crisis. According to researchers at MIT, 5 billion people, comprising 52 percent of the global projected population of 9.7 billion by 2050 will live under conditions of severe water stress and most of these inhabitants will be living in India, Africa, and the Middle East, areas already burdened by chronic water shortages.[1] The United Nations Joint Monitoring Programme has projected that the number of people living without clean water will reach 1.8 billion by 2025.[2]

Water in Modern History

Essentially, 98 percent of global water supply is salt water and undrinkable and 2 percent is fresh water. The prohibitive cost of desalinization has made this an unattainable option for most countries facing water shortage and deprivation particularly those in the developing world. Half of freshwater is not usable due to pollution and evaporation and the remaining 1 percent is under increasing population pressure that will increase significantly in the coming decades. In general, 70 percent of global freshwater is used for irrigation and 23 percent for industrial use. The amount of freshwater used for human use has increased 40 fold in the past 300 years with over half of the increase coming since 1950.[3] The amount of water directed toward irrigation is generally constant in most countries although variations do exist. For instance, approximately 86 percent of freshwater withdrawals in Asia are directed toward irrigation while the figure in India is 90 percent. Global environmental alarm over pollution and industrial waste in water is well placed given the increasing scarcity of water sources and their vulnerability as a repository for an assortment of pollutants including industrial waste, toxic waste, and raw sewage. Moreover, 1 billion people practice open defecation, a practice which has a severe health impact upon fresh water sources and water sheds. A daunting fact to consider is that global water resources have not appreciatively changed over the past two thousand years when global population was only 3 percent of our current level and furthermore, freshwater per capita availability has been falling for centuries.[4]

In 2000, the United Nations General Assembly adopted a set of human development targets known as the MDGs (Millennium Development Goals) designed to reduce global suffering on a range of important development issues. MDG7 set forth the target to "halve by 2015 the proportion of the population without sustainable access to safe drinking water and basic sanitation." Although laudable, this target was not met by many developing nations. Some commentators have criticized the United Nations for launching goals that are unreasonable in scope and unachievable in expectations. Indeed, even the UN Special Rapporteur on the human right to safe drinking water and sanitation has criticized the MDGs noting, "While the MDGs target calls for sustainable access, the monitoring framework not only fails to capture this dimension, but to some extent provides an incentive for quick solutions that have proven unsustainable in the long term."[5] In a period of 20 years, more than 180,000 hand pumps installed in rural sub-Saharan Africa failed

prematurely, representing a total failed investment of between USD 1.2 and 1.5 billion.[6] Data collected from some regions indicates that between 35 and 80 percent of water systems, such as hand pumps, were not functioning at the time the data was collected.[7]

The United Nations Committee on Economic, Social, and Cultural Rights at the twenty-ninth session in Geneva in November 2002 issued a landmark document that has provided a foundation for global water rights recognition. The document, General Comment No. 15–The Right to Water, enumerates basic rights and obligations on water that all states are urged to recognize and act upon. General Comment No. 15 affirms:

> Water is a limited natural resource and a public good fundamental for life and health. The human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other human rights. The Committee has been confronted continually with the widespread denial of the right to water in developing as well as developed countries. Over 1 billion persons lack access to a basic water supply while several billions do not have access to adequate sanitation, which is the primary cause of water contamination and diseases linked to water. The continuing contamination, depletion and unequal distribution of water is exacerbating existing poverty. States parties have to adopt effective measures to realize, without discrimination, the right to water, as set out in this general comment.[8]

General Comment No. 15 listed four major points that are directly linked to the accessibility of water and water facilities. First, physical accessibility, water locations must be within a reasonable distance. Second, economic accessibility, meaning that the costs and charges associated with securing water must be affordable. Third, nondiscrimination should be a core principle of water availability. Fourth, information accessibility so that people, particularly the marginalized, have adequate information to access water.

Water Rights and International Law

The global community has primarily shifted from customary international law practices which have been in place for centuries to the codification of law and stronger international legal regimes after World

War II, most notably with the founding of the United Nations in 1945. An evolving global consciousness on human rights is evident, however, a significant gap remains between codified treaty rights and obligations and the effective enforcement of these rights and obligations by nation states. This gap is one of the greatest challenges for international law and the advancement of progressive and effective human rights standards, particularly for marginalized and impoverished citizens in the world. The Universal Declaration on Human Rights, which the General Assembly adopted in 1948, includes many of the provisions that are now deemed to be part of customary international law and are contained in several international legal instruments. Article 25 states: "Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing, and medical care and necessary social services."[9] Although water is not specifically noted in Article 25, it is rightly assumed to be included under the general reference to a standard of living adequate for health and well-being. Subsequent international developments have sought to enumerate access to consumption of water as a fundamental right, due to growing recognition of its essential connection to health and survival.

The Geneva Conventions and their Additional Protocols recognize a right to water through Articles 20, 26, 29, and 46, Geneva Convention lll (1949); Articles 85, 89, and 127, Geneva Convention lV (1949); Articles 54 and 55, Additional protocol l (1977); Articles 5 and 14, and Additional Protocol ll (1977). A legally binding covenant is the 1966 International Covenant on Civil and Political Rights (ICCPR).[10] The General Comment by the UN Committee on Economic, Social, and Cultural Rights states: "The human right to water is indispensable for leading a life in human dignity. It is prerequisite for the realization of other human rights."[11] In view of the fact that the utility of all international treaties are incumbent upon the enforcement willpower of the signatories, the Covenant emphasizes the moral and political point that member states "have a constant and continuing duty" to initiate steps that ensure universal access to secure drinking water and sanitation facilities.[12]

On July 28, 2010, in a major step forward, the United Nations General Assembly through Resolution A/RES/64/292 recognized water security and water consumption as a human right. The resolution received 122 votes in favor and zero votes against, while 41 countries abstained from voting. The 192-member Assembly called upon United Nations member states and international organizations to offer funding,

technology, and other resources to help poorer countries scale up their efforts to provide clean, accessible, and affordable drinking water and sanitation for everyone. The resolution noted alarm that approximately 884 million people lack access to safe drinking water and a total of more than 2.6 billion people lack access to basic sanitation. A 2014 survey indicates that about 1.5 million children under the age of five die each year and 450 million school days are lost each year because of water and sanitation-related diseases.

Rights-Based and Human Security Approaches to Water Security

There are two approaches to water rights and water security development that are highly relevant and contribute to a deeper humanitarian understanding. The first is the Rights-Based approach which essentially focuses upon those in society who are the most marginalized. This approach takes into account issues of poverty, discrimination, gender, and power relations within society which certainly have a bearing upon water access. The second approach, Human Security, emerged from a landmark UNDP (United Nations Development Program) 1994 Report. The Human Security paradigm emphasizes that security requires a shift away from traditional norms of security that focus upon state interests and toward a new concept of security that recognizes first and foremost the needs and interests of the individual within society. According to the human security paradigm, there are seven threats that face individuals in situations of war, extreme poverty, marginalization, and deprivation. These include community, economic, environmental, food, health, personal, and political threats. The goal of human security is to focus upon the individual in the context of attenuating or removing one or more of these threats. With respect to water rights and access, it is evident that water insecurity poses threats to the individual in each of the seven areas. Yet the urgent need to recognize and implement a global water rights regime and national policies at the state level to safeguard and extend water rights is endangered by scarcity and poverty. According to the 2013 report of the special rapporteur on the human right to safe drinking water and sanitation, Catarina de Albuquerque, water is becoming an endangered and scarce resource for billions of global inhabitants. The report noted that while the health, human rights, and economic benefits of safe water and sanitation have been recognized by virtually all states, the implementation of these laudable goals has been severely limited. The report notes for example that in 2010, nearly all megacities were facing water scarcity and that

the growth in world population will increase water withdrawals which have tripled over the last 50 years and that demand for water and food production is projected to double by 2050.[13]

Additional human rights milestones highlighting water security include the following:

1. The Mar del Plata UN Water Conference in 1977 declared for the first time: *all peoples, whatever their stage of development and social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs.*
2. The 1979 UN Convention on the Elimination of all forms of Discrimination Against Women (CEDAW) set forth in article 14 (2) (h) a provision that women have the right to: *enjoy adequate living conditions, particularly in relation to housing, sanitation, electricity, and water supply, transport, and communication.*
3. The 1989 Convention on the Rights of the Child, the first expansive enumeration of child rights and state obligations in international law, sets forth in article 24(2) a provision for states parties to take appropriate measures to: *combat disease and malnutrition, including within the framework of primary health care, through inter alia, the application of readily available technology and through the provision of adequate nutritious foods and clean drinking water, taking into consideration the dangers and risks of environmental pollution.*
4. The January 1992 International Conference on Water and Sustainable Development, known as the Dublin Conference. Principle 4 states: *it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price.*
5. The September 1994 UN International Conference on Population and Development affirmed: *all individuals have the right to an adequate standard of living for themselves and their families, including adequate food, clothing, housing, water, and sanitation.*
6. The 1999 UN General Assembly Resolution on the Right to Development states in article 12: *the right to food and clean water are fundamental human rights.*
7. In 2000, the UN sets forth the *Millennium Development Goals* (MDGs) a set of ambitious human development goals to be achieved by 2015. MDG 7 addresses access to safe, clean water sources. MDG 10 addresses access to safe sanitation.
8. In 2005, the UN declared *2005–2015 to be a Decade for Water.*
9. In July 2010, the General Assembly for the first time recognizes the Right to Water and Sanitation. The resolution calls upon:

states and international organizations to provide financial resources, help capacity-building and technology transfer to help countries, in particular developing countries, to provide safe, clean, accessible, and affordable drinking water and sanitation for all.

10. In September 2010, United Nations Human Rights Council Resolution 15–9 affirms: *the rights to water and sanitation are part of existing international law and confirms that these rights are legally binding upon states.*

Water Rights, Sanitation, and Health

The tragic global picture on water-related disease and fatality is a powerful reminder of the urgent need for ambitious and generously funded international and national development campaigns targeting safe, clean water sources and adequate sanitation. The 2010 UN Environmental Programme Report stated, "Over half of the world's hospital beds are occupied with people suffering from illnesses linked with contaminated water and more people die as a result of polluted water than are killed by all forms of violence including wars."[14]

Diarrheal Diseases

Infectious diseases, particularly diarrhea, followed by malaria, constitute the majority of water-related child deaths in the developing world. Approximately 88 percent of diarrhea cases worldwide are caused by inadequate access to clean water and safe sanitation systems. The World Health Organization notes that in Southeast Asia diarrhea is responsible for 8.7 percent of all deaths. In India, over 1 million children under the age of 12 months died from diarrhea in 2013, according to a report in the British medical journal, *Lancet*. Diarrhea, an easily treatable minor health issue in the developed world, poses a major threat to health and life in much of the developing world. The UN World Water Development report concluded that, "diarrheal diseases are the most destructive of the faeco-oral diseases, causing around 1.6 to 2.5 million deaths annually, many of them among children under the age of five who live in developing countries."[15] In 2008, diarrhea was the leading cause of death among children under the age of five in sub-Saharan Africa, and was responsible for 19 percent of all deaths in this age group.[16] The report further notes that "diarrhea is caused by a wide variety of microorganisms, including viruses, bacteria and

protozoa. Rotavirus is the most common cause of watery diarrhea in children in developed as well as developing countries. The primary pathway of rotavirus transmission is fecal-oral and infection can occur through ingestion of faecally contaminated water or food and contact with contaminated surfaces. An important cause of diarrhea, especially in developing countries, is *Shigella*; infection with this bacterium often leads to bloody diarrhea (dysentery). Typical for *Shigella* is the very small infective dose; therefore, it can spread easily from person to person."[17] Effective global health interventions for preventing diarrhea include: (1) access to safe drinking water; (2) improved sanitation; (3) healthy personal and food hygiene; (4) health education. The successful implementation of these measures is often limited by poverty, pollution, and water scarcity.

Malaria

Malaria remains a major health challenge to children in the developing world. It is caused by a parasite carried by certain types of mosquitoes. Annually there are an estimated 300 million to 500 million cases of malaria throughout the world and about one million child deaths.[18] The use of mosquito nets has proven to be an effective limitation upon the spread of the disease, however the cost of the nets themselves may be prohibitive in many impoverished households and communities. Another common and more effective approach is to limit or remove the amount of standing water which is a prolific breeding ground for mosquitoes.

Other Waterborne Diseases

Globally, there are about 200 million people infected with schistosomiasis, which causes a host of chronic and debilitating symptoms that can result in death. Schistosomiasis is caused by three main species of flatworm, namely *Schistosoma haematobium*, *S. japonicum,* and *S. mansoni.* Infection may occur when children and adults enter larvae-infested water. As reported in the UN World Water Development report, "after skin penetration, the larvae transform and are carried by the blood to the veins draining the intestines or the bladder where they mature, mate and produce eggs. Eggs cause damage to various tissues, particularly the bladder and liver. The reaction to the eggs in tissues causes inflammation and disease. When infected humans excrete parasite eggs

with feces of urine into water, the eggs hatch releasing larvae that in turn infect aquatic snails. Schistosomiasis is endemic in 7 countries, most of which are in Africa."[19]

Intestinal Helminth Infections

The roundworm (*Ascaris*), the shipworm (*Trichuris*), and hookworms (*Anacylostoma* and *Necator*) are mainly transmitted through soil that is contaminated with human feces and are, therefore, directly related to the caliber of sanitary facilities. These soil-transmitted helminthes flourish where poverty, inadequate sanitation, and minimal health care prevail. In, 1947, it was estimated that 1.5 billion people were infected, while in 2006, the figure was an estimated 3.5 billion.[20]

Dengue Fever

Dengue is a mosquito-borne viral disease that infects millions of people worldwide. In the last 50 years, the incidence of dengue fever has increased exponentially. Today, approximately 2.5 billion people in more than 100 countries are at risk. "Up to 50 million infections occur annually, with 500,000 cases of dengue hemorrhagic fever and 22,000 deaths, mainly among children. Prior to 1970, only nine countries had experienced cases of dengue hemorrhagic fever (DHF); since then the number has increased more than fourfold and continues to rise."[21] Dengue is found in the Americas, Southeast Asia, South Asia, and the east coast of Africa, the eastern Mediterranean, and the Western Pacific regions.

The following chapters outline the water scenario in nine countries: Myanmar, Cambodia, China, India, Indonesia, Laos, the Philippines, Thailand, and Vietnam, with respect to water rights, water access, health, pollution, scarcity, and future development issues. Two of these countries, China with a population of 1.2 billion and India with a 1.1 billion population, collectively hold almost one-third of humanity. These two countries face perhaps the greatest crises in terms of providing water needs for massive populations that are threatened by global warming, pollution, uneven human development, and wide-scale water scarcity affecting millions of citizens. India's annual population growth of 1.8 percent translates into 20 million additional people every year. China's annual population growth rate of 0.9 percent adds about 11 million people per year to the population. Aside from population pressures

on water, all the countries of Southeast Asia face serious water-related challenges that in many states are exacerbated by extreme poverty.

The ADB (Asian Development Bank) and the Asia-Pacific Water Forum have outlined a Water Security Framework that highlights five critical dimensions. These five dimensions include:

(1) Household Water Security
(2) Economic Water Security
(3) Urban Water Security
(4) Environmental Water Security
(5) Resilience to Water-Related Disasters.

Household Water Security: In Asia and the Pacific, 60 percent of the households live without a safe, piped water supply and improved sanitation, inequity in access to water is highest in South Asia.[22]

Economic Water Security: Asia and the Pacific agriculture accounts for 79 percent of annual average water withdrawals and demand for food and animal feed is predicted to grow by 70 percent to 100 percent over the next 50 years. South Asia which includes India is the poorest and most populous subregion and has low agricultural water productivity.[23]

Urban Water Security: More than half the world's slum dwellers live in Asia, wastewater is frequently released into rivers, lakes, and groundwater untreated or poorly treated. In South Asia, as little as 22 percent of wastewater discharges are treated.[24]

Environmental Water Security: 80 percent of the rivers in the Asia region are in poor health as measured by the river health index. Pollution from cities aggravates the problem. South Asia, Central and West Asia have rivers assessed as being in the poorest health with selected rivers in India and Armenia having the poorest health ratings. Azerbaijan, Bangladesh, Thailand, Pakistan, and Sri Lanka all have rivers that are in such poor health that environmental water security is threatened in these basins. 60 percent of the world's population lives in Asia, which has the lowest per capita availability of freshwater. South Asia has the lowest environmental water security.[25] Moreover, climate change, the effects of which are already noticeable and devastating for many regions of the world, will contribute to a litany of challenges including flooding, drought, rising sea levels, saltwater intrusion on low land areas and valuable agricultural lands, extreme temperature patterns, increased health crisis such as malaria from rising temperatures and higher mosquito populations, storm surges, unpredictable weather patterns,

environmental refugees in the millions, reduced development goals, and water scarcity.

Resilience to Water-Related Disasters: Over 90 percent of the disasters are water-related including floods, droughts, hurricanes, storm surges, and landslides. Asia and the Pacific is the most vulnerable region in the world to water-related disasters; the cost of flood disasters alone reached USD 61 billion in 2011.[26]

Water Overview: Southeast Asia and India

Approximately 800 million people lack access to improved water sources, which represents 12 percent of global population. The challenge of safe water is the paramount challenge for humanity. It is a crisis that transcends culture, geography, religion, and ethnicity. Former United Nations Secretary General Kofi Annan has stated that, "we shall not finally defeat AIDS, tuberculosis, malaria, or any of the other infectious diseases that plague the developing world until we have also won the battle for safe drinking water, sanitation, and basic health care."

A review of the major socioeconomic and water health issues reveals the daunting depth of the problems that confront Southeast Asia and India. In the Southeast Asia region, 20 percent of the total population live in poverty. In Laos, only 51 percent of the population has access to clean water. In the Philippines, waterborne disease is a major threat and only 7 percent of the population is connected to a sewerage system, which dramatically elevates the disease risk. Sanitation-related deaths totaled 9000 in Vietnam and 11,000 in Cambodia in 2007 and 50,000 in Indonesia. Water pollution plagues many of the Southeast Asia countries and India. India has 14 major rivers and all are severely polluted. It has been estimated that in New Delhi, the capital, 200 million liters of raw sewage per day is dumped into the Yamuna River. 20 major Indian cities currently face sustained water shortages and the number is expected to rise. A 1996 study in Thailand revealed that water pollution has caused rivers to contain 30 to 60 times more pathogens, heavy metals, and poisons from industry than government standards permit while 80 percent of China's rivers rank as severely polluted and no longer capable of sustaining fish life. According to a recent report on international water management, "water scarcity and water pollution are becoming the accepted norm in many river basins in Asia and the Pacific."[27] Moreover, a report by ADB and the

Asia-Pacific Water Forum noted that there are clear indications of increasing water scarcity and environmental stress in large parts of important agricultural areas in Asia and groundwater levels are falling in India and the northern plains of China.[28]

The United Nations MDGs were formulated to confront major global development crises with significant achievement targets set for 2015. The aim of Target 7C is to "halve by 2015 the proportion of the population without sustainable access to safe drinking water and basic sanitation." MDG Target 10 set a goal "to reduce by half the proportion of people without access to improved sanitation." As numerous international development experts including those from the UN have noted, Target 7 and 10 were not achievable for many developing countries by 2015 due to the magnitude of the poverty and other challenges. According to the 2012 UN Water Report, "even if the rate of progress cited in the World Health Organization/UNICEF 2012 report were to continue to the end of the MDG period, universal water and sanitation coverage would still be far off in 2015, 605 million people would remain without access to an improved drinking water source and 2.4 billion people would be without access to improved sanitation facilities. Given this scenario, billions will remain at risk of WaSH-related diseases such as diarrhea which in 2011 killed 2 million people and caused 4 billion episodes of illness.[29] The WASH program (water and sanitation hygiene) is a critical development initiative which the UN endeavors to continue in numerous developing countries. In Asia, the percentage of people with access to improved sanitation increased from 36 percent in 1990 to 58 percent in 2010, however 1.75 billion people continue to live without access to improved sanitation. The global community is not on target to meet the MDG sanitation target of 75 percent and is projected to miss the target by more than half-a-billion people. Some development and UN experts suggest that the target may not be reached until 2026. In the Southeast Asia region, Cambodia, Indonesia, and the Philippines missed the 2015 MDG sanitation target. India also missed the 2015 target. In South Asia, only 38 percent of the population has access to improved sanitation. Another major obstacle to sanitation progress is the massive gap in income equity that persists in Asia and particularly in India. Within India, it is estimated that 90–96 percent of the rural rich have access to sanitation while only 2–4 percent of the rural poor have access.[30] Approximately 97 million people in India have no access to clean water sources, 800 million have no access to proper sanitation systems, and the poverty rate is 30 percent.

The global incidence of arsenic in drinking water highlights the growing recognition that arsenic exposure is a major public health threat that demands immediate action. Vietnam, Cambodia, Laos, Thailand, India, and Cambodia have documented cases of serious arsenic contamination in water sources including tube wells. Arsenic is a known carcinogenic and responsible for a host of other serious health problems. Scientific studies are increasingly reporting on the substantial health threats to millions of people that is caused by arsenic contamination. Moreover, people exposed often take 15–20 years to become symptomatic.

Climate Change

Climate change is an inevitable process in the current global environmental reality. It is a phenomenon that has an alarming and destructive impact upon many countries, particularly in the developing world. Approximately 97 percent of climate scientists agree that climate change and global warming over the past 100 years were caused by human activities.[31] Climate change has had and will continue to exert incalculable effects upon a myriad of health, development, economic, and environmental issues. The weather implications of climate change include flooding, fluctuating temperatures, drought, damaged or flooded crops, flooding of lowland regions and agricultural lands, and food security stress. Moreover, a range of health implications are also associated with climate change that in many cases fall disproportionately and negatively upon the poor and nations that are developing and unable to sustain the human and economic costs related to climate change. Many scientists predict that the general impact of climate change upon freshwater sources will be negative. Thus both climate change and rapid population growth over the next 50 years will place additional burdens upon diminishing water sources. Climate change is intricately linked to food security, particularly in Asia and India, where rice is a major source of food. It has been noted that irrigation for agriculture consumes about 70 percent of total freshwater sources. In some countries, such as India, the figure is closer to 90 percent. Limitations upon freshwater sources, either due to climate change or human caused pollutants, will further exacerbate food security in the developing world. According to the United Nations IPCC 2014 report, by the 2070s, the major Asian cities in terms of population exposure to coastal flooding are expected to be Kolkata, Mumbai, Dhaka,

Guangzhou, Ho Chi Minh City, Shanghai, Bangkok, Rangoon, and Hai Phuong. The report noted that the combined effect of climate change and over-withdrawal of groundwater in many Asian cities, such as Bangkok, Manila and Tianjin will likely result in land subsidence and may increase hazard exposure due to coastal inundation and sea-level rise. Climate change also threatens to disrupt basic services such as water supply, sanitation, energy provision, and transportation systems, which has serious implications for local economies and in some cases could lead to mass migration."[32]

A relevant aspect of water rights and water security is the massive growth of the urban population centers in the developing world. Migration patterns over the past 100 years indicate a general and irreversible global shift from the rural to the urban population. Megacities in Asia and India became a common reality in the twentieth century and represent an evolution that is predicted to rise significantly in the foreseeable future. By 2050, it is estimated that 70 percent of global population, equal to 6.4 billion people, will live in cities. Current megacities such as Beijing, Mumbai, Shanghai, Kolkata (Calcutta), Jakarta, Manila, Bangkok, and Ho Chi Minh City, that already experience varying degrees of water pollution, contamination, and water shortages, are set to endure steadily rising population bases. Clearly, the Southeast Asia region and India face enormous and protracted challenges when it comes to water security, water health, and proper sanitation. These issues could not be more urgent given the serious population pressures combined with global warming, pollution, water shortages, and unsafe sanitation systems that are affecting millions of people in the region at alarming and dangerous levels.

CHAPTER ONE

Myanmar: Resolving Water Insecurity and Poverty

Country Overview

Myanmar (formerly known as Burma) is one of the poorest countries in Southeast Asia. It is an emerging democracy that is confronted with major development and human rights challenges after decades of oppressive military rule. Waterborne and food-borne diseases are common. The infectious disease ratio in the country is high including malaria and typhoid fever. The large ratio of rural inhabitants, 70 percent, combined with a high poverty index pose significant challenges that threaten water, sanitation quality, and access. The marginalization of indigenous groups, such as the Karen population, has been an ongoing human rights issue for decades. Moreover, there are significant health, economic, and development gaps between the rural and the urban areas of the country. Southeast Asia accounts for 60 percent of global population yet has only 36 percent of global water resources. Myanmar has abundant water sources and has the second highest per capita rate of renewable water resources in Southeast Asia. The problem rests with water access, infrastructure, and quality control. About 29 percent of the population from 2010 estimates are children of 0–14 years, declining from 39 percent in 1980.[1] The estimated population of children under the age of 5 years was 6.6 million, approximately 11.7 percent of the total population.[2]

Acute diarrhea is the second most common cause of death in under-five children (17.6 percent). Improving water and sanitation facilities

for children will significantly improve the childhood disease ratio and generally lead to a decline in the overall health burden of the country.

Major health, economic, and water indicators

Human Development Index (HDI) for Myanmar, 2014: 150
Population, 2014: 53.26 million
Gross national income (GNI) 2011: USD 1247.00
Life expectancy 2012: Female: 65.1
Male: 62.2
Improved rural water source 2012: 81 percent
2010: 78 percent
Population percentage with access to improved sanitation, 2013: 76 percent
global average: 72 percent
Rural population, 2012: 66.8 percent
Poverty index, 2012: 27.6 percent
Homeless population, 2014: 0.293 percent
Carbon dioxide emissions per capita (tons) 2014: 0.17

There are eight major ethnic groups in the country. The Bamar forms the largest group, approximately two-thirds of the population, which mainly resides in the central and delta regions. The remaining seven ethnic groups are the Kachin, Kayah, Kayin, Chin, Mon, Rakhine, and Shan, which are further subdivided into 135 ethnic groups. The country is composed of four ecological regions: the hilly region, the dry zone, the delta region, and the coastal region. There are four main river systems that are water resources and ten major river basins. However, drinking water shortages occur in many parts of the country. Water stress is common in dry, arid zones resulting in water insecurity and affecting accessibility to clean water. Moreover, there is potential conflict among water users particularly when faced with situations of drought or natural disasters.[3] Access to an improved water source in 2010 was 75 percent in the urban areas and 69 percent in the rural areas.

Rangoon: City Water Profile

Rangoon (also referred to as Yangon) was founded in the eleventh century and is located at the confluence of two important rivers, the Yangon and the Bago. It is the largest city in the country and has a population of approximately 5.21 million (2014). The growth rate is almost twice the national average. Municipal services are generally

underdeveloped and inadequate to serve the rapidly growing urban population. Most urban poor cannot afford to pay the average 500 MMK for a water tank. Their only option is to rely upon tap water and water from public pots which are common. These drinking sources are generally not free from contaminants that cause illness. According to recent estimates, the public water supply is vulnerable and up to 60 percent of water is lost due to leakage and waste. A Japanese study in 2014 reported on the quality of drinking water in two major cities, Yangon and Nay Pyi Taw. Although Nay Pyi Taw was determined to have generally good water quality, significant water quality problems were identified in Yangon. The scientific study collected and analyzed drinking water samples from several sources including public pots, non-piped taps, piped taps, and bottled water. Piped tap water was collected from three taps in Yangon and non-piped tap water was collected from a pagoda and another building. Drinking water was also collected from public pots located along roadsides and analyzed. In Yangon and in other cities, it is a common practice for pots to be filled with water, covered, and placed along roadsides. The study concluded with several significant health and environmental findings.

> Environmental water quality was surveyed in the Yangon region. The results of bacterial parameters indicated that they can be used for drinking after advanced treatment. Among the sampling points on the Yangon River, R2 was located on the left riverbank, whereas R3 and R4 were located in the center of the river. The total coliform value was highest at R2 on the left riverbank, which was closest to urban activity. Drinking-Water Quality: potable drinking-water quality was surveyed for various water sources in Myanmar including (i) public pots, (ii) piped water supply in Yangon and Nay Pyi Taw, (iii) non-piped water supply, and (iv) bottled water. For bacterial water quality, e-coli was not detected in 1mL water samples from any water source. From these results, we concluded that water from all pots, all non-piped taps, one piped tap, and one bottled water exceeded the converted value of the Japanese drinking-water-quality standard and may not be suitable for drinking. As and F− were present at relatively high concentrations and must be removed before deep wells can be used. Heterotrophic plate counts in drinking water were highest in pots, followed by non-piped tap water, piped tap water, and bottled water samples. Measures need to be taken to improve the poor water quality in pots and non-piped taps.[4]

With rapid population growth expected to continue in Yangon, it is imperative for the government and the NGO (nongovernmental organization) community to concentrate more resources and technology on the water and sanitation infrastructure to prevent major health and economic difficulties.

Health and Human Rights Challenges

Waterborne diseases due to unsafe drinking water and unhealthy sanitation practices are among the leading causes of death in less-developed countries. In Myanmar, among the ten leading causes of death, diarrhea and acute gastroenteritis are ranked fourth. Both of these conditions are linked to unclean water and unsafe sanitation practices. Waterborne diseases listed by the National Surveillance System include diarrhea, cholera, dysentery, and viral hepatitis. The infectious disease risk in Myanmar is very high. Food- and waterborne diseases include bacterial and protozoal diarrhea, hepatitis A, and typhoid fever; vector-borne diseases include dengue fever, malaria, and Japanese encephalitis; a common water contact disease is leptospirosis.[5] Approximately 29 percent of the population according to the 2010 Census figures are children of 0–14 years, declining from 39 percent in 1980. "The estimated population of children under the age of 5 years was 11.7% in 2012. Acute diarrhea is the second most common cause of death in under-five children (17.6%). Nevertheless, there is a decrease in the under-five mortality rates from 77.8 per 1,000 live births in 2001 to 46.1 per 1,000 live births in 2010."[6] The situation in many parts of Myanmar vis-à-vis child rights and water health is tenuous in many parts of the country. This difficult reality is more evident in rural communities where poverty and health deficiencies are obvious compared to urban areas. Implicit in the universally recognized right to water is the right to drinking water and adequate sanitation. As safe drinking water is fundamental to health and life it is therefore regarded as a foundational right. Myanmar is one of the signatories to the CRC (Convention on the Rights of the Child) in 1989. This humanitarian action was taken by the government to observe the 2010 resolutions recognizing safe and clean drinking water and sanitation as basic human rights at the United Nations General Assembly. Accordingly, at the World Health Assembly in 2011, Myanmar agreed to adopt resolutions for safe drinking water and sanitation for both adults and children. A survey conducted by the International Water Management Institute noted that 62.2 percent of the poor and marginalized populations had

access to safe drinking water in dry zones in contrast to 71.9 percent among the nonpoor.[7]

A survey was completed by the Department of Health in conjunction with UNICEF in 2011 on the knowledge and practices of the communities on water, sanitation, and hygiene in over 6,000 households in 24 townships of 9 states and regions across Myanmar. Over two-thirds of surveyed households used improved water sources for drinking across all seasons and half of these households did not use an adequate method of treating their water at home. Almost a third of the household latrines were located within 50 feet of a water source, and only 17 percent of households used a safe way to handle water before drinking. About two-thirds of the households had to fetch water, and twice as many women fetched water than men, with most of the households spending less than 30 minutes to fetch water. The survey found that the community members are quite aware of how a water source can be contaminated and the potential negative impact of unclean water on health. Most strikingly, 8 percent of households with children under 5 reported diarrhea during two weeks preceding the survey. Results indicated gaps in knowledge and real practice for household water purification and other hygienic behaviors that required strengthening.[8]

A 2012 cross-sectional descriptive study examining 250 children under the age of 12 with acute diarrhea attending five hospitals in Yangon City revealed the isolation of bacterial pathogens from 60.8 percent of rectal swabs which comprised *Escherichia coli* (63.8 %) followed by *Vibrio cholerae* (14 %), *Shigella dysentriae* (7.2 %), and *Salmonella spp.* (6 %). The results indicated the likelihood of contamination from the unsanitary environment especially water and sanitation and unhygienic behaviors being attributable to acute diarrhea in children.[9] Exposures to multiple environmental contaminants place children under five years of age at a greater risk to acute diarrhea and acute respiratory tract infections.

Migrant populations are also at risk from exposure to poor water, sanitation, and unhygienic practices that lead to waterborne diseases. A cross-sectional study conducted by the NMCP (National Malaria Control Program) in collaboration with the Department of Medical Research (Lower Myanmar) and WHO (World Health Organization) between June and December, 2013 covered 1,899 mobile migrant groups from 16 Tier II townships of Myanmar Artemisinin Resistance Containment Zone. Nearly 50 percent of those migrant groups had approximately 8,000 children under five years of age. Only 16 percent received water from tube wells of improved source and 36 percent had access to sanitary latrines.[10] There has been a noticeable increase in

access to an improved water source and clean water in both urban and rural households in the country over the past decade. Yet it remains evident that access to clean water is far lower in rural areas compared to urban areas due to poverty and underdevelopment, particularly in the Kayin and Rakhine States. Approximately 53 percent of schools in rural communities have water supply and only 30 percent of households have a water source inside the domicile. A high prevalence of acute diarrhea has been observed in under-five children in selected peri-urban households and a high level of drinking water contamination with fecal coliforms was detected though it was unclear whether this was due to contamination at sources or at point-of-use. Particularly at the rural level, there are income inequities, uneven service delivery, weak water delivery infrastructure, and inconsistent water sources along with inadequate water quality in many locations. This has a clear impact upon water quality and health for millions of rural citizens.

Cyclone Nargis

Cyclone Nargis, which struck with ferocity on May 2, 2008, caused massive death, property damage, and the destruction of the majority of wells that were the main water supply for 1.8 million people. The cyclone hit five states and regions including Ayeyarwady, Yangoon and Bago Divisions, Kayin, and Mon States. According to Government data, there were 84,537 deaths, 53,806 missing, 2.4 million affected or displaced, and damage of 11.7 trillion MMK (USD 4.1 billion).[11] Many of the regions and communities worst affected were already facing chronic issues of poverty and disease. The areas devastated by the cyclone and flooding produced 65 percent of the country's rice, 80 percent of the aquaculture, 50 percent of the poultry, and 40 percent of the pig population.[12] Several serious health crises were triggered by the cyclone including widespread communicable diseases such as malaria, dengue fever, and measles. Major health, development, and disease incidents caused by Cyclone Nargis included:

1. Interruption of safe water, sanitation, and cooking facilities due to the disruption of electricity and fuel supplies. The populations displaced by the cyclone are at immediate and high risk of outbreaks of waterborne and food-borne diseases.
2. Population displacement with overcrowding. Populations in the affected areas and relief centers were at imminent and high risk

from the transmission of measles and at increased incidence of ARI (acute respiratory infections). In general, increased risk of meningitis transmission is associated with overcrowding.
3. Increased exposure to disease vectors. Displacement of populations often leads to increased exposure to disease-carrying vectors, increasing the risk of malaria and dengue. Other disease risks included plague, chikungunya, and hantavirus infection.
4. Malnutrition and transmission of communicable diseases. The combination of malnutrition and communicable diseases with a natural disaster created significant public health problems particularly in infants and children. Malnutrition compromises natural immunity thus leading to more frequent and severe episodes of infections. Moreover, severe malnutrition often masks symptoms and signs of communicable diseases, making prompt clinical diagnosis and early treatment more difficult.
5. Poor access to health services is of immediate concern. The damage caused by the cyclone to the health infrastructure is preventing access to usual services, as well as to emergency medical and surgical services being put in place in response to this emergency.
6. As flood waters recede, increased malaria vector breeding resulting in increased malaria transmission will become an issue usually after 2–3 weeks.[13]

The Ayeyarwady Delta has a population of 8.1 million and is an extensively cultivated agricultural area. It is a region with significant poverty. About 40 percent of households are landless, a figure that increased to 75 percent after Cyclone Nargis. Moreover, the cyclone caused tremendous damage to the water infrastructure and water sources. The fact that area residents rely extensively upon ponds, dug wells, and tube wells for water made the cyclone catastrophe all the more devastating due to the destruction and contamination of water sources that is common in natural disaster scenarios. Flooding in the low lying areas, tidal waves up to 3 m high, and heavy salinization were further complications to water security and health for area residents.

Arsenic in Water

Arsenic contamination of drinking water sources is a common health problem in many Southeast Asia states including Myanmar. Since water quality monitoring is a recent development in the country there

are millions of people exposed unknowingly to serious contaminants and thus elevated health risks. After the severe flooding of 1997 in Myanmar, SC UK initiated a water and sanitation rehabilitation project in 12 flood-affected rural townships. The project facilitated the construction of 50,000 household latrines and constructed/rehabilitated village drinking water sources including 957 sludge-drilled STWs (shallow tube wells). More than 60 percent of project achievements—30,000 household sanitary latrines and 615 water supply projects were located in four Ayeyarwady Division Townships. Based upon geographical similarities between Myanmar and Bangladesh delta regions, SC UK expressed suspicions of arsenic contamination of groundwater, especially in those communities located in the Ayeyarwady River Delta. A preliminary water quality survey was carried out by SC UK in 63 project communities during March–May 2000. The results revealed that arsenic contamination in excess of the proposed Myanmar national standard of 0.05 mg/l was present in 35 percent of the 145 inspected STWs, thus confirming initial concerns.[14]

Major findings of a study on arsenic traces in drinking water revealed disturbing health implications. The following conclusions have been reported:

1. Seasonal variation in arsenic levels of groundwater sources is pronounced in the project communities (maximum variation is found to have +0.3 mg/l to −0.2 mg/l).
2. Arsenic contamination was present in hand dug wells (11 percent and 3 percent of n=175 were exceeding the WHO and the proposed Myanmar National Standard respectively.)
3. Based on group discussions with community members, it is estimated that less than 20 percent of pilot project communities currently use contaminated sources for drinking and cooking. Prior to the project, knowledge of naturally occurring arsenic contamination of water sources was negligible. After awareness raising campaign in project villages, knowledge had significantly improved.[15]

The Myanmar Ministry of Health reported in 2010 that based upon surveys conducted in 12 regions of the country, arsenic contaminated water was discovered in all 12 regions above the permissible level of 10 ppb (parts per billion) established by the WHO. The highest levels were found in water in Rakhine (Arakan) State, Irrawaddy (Ayeyarwady), and Pegu (Bago) Divisions.

Environmental Challenges

Myanmar has the second largest level of renewable water resources per inhabitant in Southeast Asia. Yet the country still has serious problems with water quality, access, and supply. Inadequate sanitation measures may lead to fecal contamination and bacteria in the water sources for domestic use. During the monsoon season, frequent flooding carries sewage and fertilizer into rivers, lakes, and ponds which represent essential water sources especially in rural areas. There is growing pollution of water sources, especially through industrial waste, mining, and aquaculture. In many parts of the country, large stretches of rivers are heavily polluted and lack adequate flow capacity to support aquatic ecology, cultural needs, and aesthetics.[16] Waste water from factories of Hlaing Tharyar and South Dagon industrial zones included certain concentrations of copper, manganese, and iron higher than WHO recommended guidelines.[17] These findings and other incidents of rampant pollution highlight the urgent need for stronger environmental standards and inspection capacity in the country.

The Salween River

The Salween River at 2,815 kilometers, which flows through China, Thailand, and Myanmar, is the second longest river in Southeast Asia. It originates 4000 meters above sea level in the Tibetan Plateau and flows into the Andaman Sea. In Myanmar, several indigenous groups utilize the river. These tribal groups include the Karen, Nu, Lisu, Shan, Karenni, Wa, Ta, Mon, and Yintailai. The River forms a vital trade and travel route between these tribal communities. In Myanmar, it is estimated that seven million people depend upon the river for their livelihood. The Salween River is one of the ten most polluted rivers in the world.[18] It is threatened by extensive dumping of chemical toxins and sewage. The river hosts 140 varieties of fish and is a source of irrigation and drinking water for millions of people. The Myanmar and Thai governments are proceeding with planning for five massive dams on the Salween River and its tributaries, which are Hatgyi, Tasang, Wei Gyi (Upper Salween Dam), Dagwin (Lower Salween Dam), and Upper Thanlwin.

Along the Salween River in Myanmar and Thailand there are over a hundred species of fish that migrate between the Salween and its tributaries. These fish are an essential source of food and economic livelihood for thousands of Thai citizens and villagers in the Karen,

Karenni, Mon, and Shan States in Myanmar. Ambitious plans for dam construction are cause for concern to thousands of local inhabitants and environmentalists. According to the NGO Burma Rivers Network, "large dams are being constructed on all of Burma's major rivers and tributaries by Chinese, Thai, and Indian companies. The dams are causing displacement, militarization, human rights abuses, and irreversible environmental damage, which is threatening the livelihoods and food security of millions. The power and revenues generated are going to the military regime and neighboring countries."[19]

Climate Change

The impact of climate change will dramatically effect Myanmar due to a number of critical factors including low sea elevations, poor infrastructure, and poverty. Climate change and irregular rainfall patterns in recent years have led to crisis points in the dry zone of the country. Health burdens from climate change will be measureable on issues such as increased malaria caseloads due to rising temperatures. Changing aquatic ecosystems in Myanmar "which inevitably lead to more fertile habitats for water-related intermediate hosts of parasites that are particularly adverse to children. These parasites include schistosomes, food-borne trematodes and soil-transmitted helminthes. Constant monitoring is essential in neighborhoods of natural and man-made freshwater bodies."[20] The visible effects of climate change include elevated temperatures, shorter monsoon seasons, and greater frequency and intensity rainfall and cyclones. Flooding is a major concern and consequence of climate change in the country. Lowland areas in the Ayeyarwady Delta, where 8 million people live, are extremely vulnerable. The majority of people in the Delta earn their livelihood from agriculture and flood risk is accelerated due to climate change. Moreover flood risk poses severe economic, social, and health burdens upon the 40 percent of householders who are landless. Thus increased migratory patterns, even the prospect of environmental refugees, are expected for the rural inhabitants in the Ayeyarwady Delta.

The Global Climate Risk Index 2015 analyses the impact of climate change upon countries. Weather crises from climate change include storms, floods, and heat waves. According to the index, for the period from 1994 to 2013, Honduras, Myanmar, and Haiti rank highest. "Between 1994 and 2013, more than 530,000 people died worldwide and losses of USD 2.17 trillion (in PPP) were inflicted as a direct result of over 15,000 extreme weather events. The 2014 New Climate

Economy Report forewarns of similar disasters that will occur if no action towards limiting global temperatures to 2°C is taken, with many of these events affecting developing countries whose vulnerability to climate change is particularly high."[21]

Drought is a chronic problem in the country and has a considerable impact upon health, economic hardship, agricultural losses and GDP decline. In addition, Myanmar ranks first as the "most at risk" nation in the Asia-Pacific region according to the UN Risk Model. The nation is routinely hit by a devastating array of severe environmental incidents such as floods, cyclones, earthquakes, landslides, and tsunamis. In 2012 alone, the country faced extensive damage, health burdens, and fatalities from flooding. In August 2012 the monsoon season caused flooding in many regions of the country and 6000 people were rendered homeless when the Salween River in Karen State flooded. In the Irrawaddy region, the Darka River overflowed its bank which caused extensive damage that affected over 12,000 people.

The Myanmar Government report on adaption to climate change notes the following adverse environmental eventualities over the 2001–2100 time frame:

a general increase in temperature across the whole country, particularly from December–May with the central and northern regions experiencing the greatest increases;
an increase in clear sky days exacerbating drought periods;
an increase in rainfall variability during the rainy season including an increase across the whole country from March—November (particularly in Northern Myanmar), and decrease between December and February;
an increase in the risk of flooding resulting from a late onset and early withdrawal of monsoon events;
an increase in the occurrence and intensity of extreme weather events, including cyclones/strong winds, flood/storm surge, intense rains, extreme high temperatures, and drought.[22]

In the report, the government also enumerated the leading causes contributing to the nations' high level of vulnerability to climate change. The following points were highlighted:

employment and the national income is dependent on climate-sensitive sectors such as agriculture, forestry, and natural resources;

human populations and economic activities are concentrated in the coastal zone as well as in low-lying lands and are therefore exposed to long-term climatic impacts such as sea level rise as well as an increase in cyclones and storm surge/flooding;
exposure to both geological and meteorological hazards (e.g., earthquakes, floods, cyclones, and tsunamis) as a result of the country's southwest location within the Bay of Bengal as well as its long and low-lying coastal zone which stretches across the Arabian and Indo-Chinese Tectonic Plates;
high poverty levels which affect the capacity of the country to respond to climate change-related impacts;
limited technological capacity to prepare for the impacts of climate change or the consequences of climate change-related events.[23]

Further warnings have been issued over the high level of vulnerability in food security and agriculture as a result of climate change. Combined, these prognoses for the country paint a stark picture that will confront the nation and citizens in all regions with daunting health, economic, and social challenges.

Government Water Policy and Laws

Water and sanitation policy and laws are at a rudimentary level in Myanmar and have not kept pace with urgent development needs. Government departments with responsibilities related to water and sanitation issues include the Departments of Irrigation, Meteorology and Hydrology, Forestry, Water Resource Utilization, Water Resources and Improvement of River Systems. Municipal agencies such as City and Township Development Committees are responsible for urban water supply and the DRD (Department for Rural Development) is responsible for rural water supply. The ESD (Environmental Sanitation Division) from the DOH (Department of Health) is responsible for the WSP (water safety plans) and improved sanitation and hygiene activities fall under the responsibility of townships and rural health centers. The division also plans and implements pilot projects on water quality surveillance and monitoring system. In line with the National Comprehensive Development Plan for the health sector as stated in Vision 2030, the current policy and institutional reforms for health system strengthening cover policy and legislation, universal health coverage, and strengthening of health information systems. The Constitution

does not presently safeguard protection for the right to water or outline responsibilities of the state to ensure access to safe drinking water and sanitation. Moreover, there is no National Water Resources Policy.

Major policy initiatives include the following:

1. The National Environment Policy was established in 1994 with responsibility for effective and sustainable environmental policies related to the utilization of water, land, forests, mineral resources, and other natural resources to preserve the natural environment and prevent its degradation.
2. The MWRC (Myanmar Water Resources Committee) was established in 2005 and is planned together with the formulation of a SMP (strategic management plan) to support the application of IWRM (integrated water resources management) in the country.
3. The Conservation of Water Resources and Rivers Law was set up in 2006 with the goal to conserve and protect water resources and rivers from environmental degradation.
4. In 2012, the ESD (Environmental Sanitation Division) and the Health Education Bureau from the Department of Health in collaboration with UNICEF set up community health engagement workshops based upon the "Four Cleans" campaign of clean food, clean water, clean toilet, and clean hands.
5. The NWRC (National Water Resource Committee) was established by presidential decree on July 25, 2013 and chaired by the vice president and implements the multipurpose water management system.

Water Development Project Profile

Water insecurity can lead to health, economic, and environmental crises. In areas facing water scarcity, both the public and private sectors in Myanmar attempt to support clean water programs through funding from IDA (International Development Agencies)/Banks and United Nations Agencies. Tools to improve the situation of WaSH in Myanmar include water safety planning and CLTS (Community-Led Total Sanitation). The latter approach is based on the active realization and engagement of communities in solving their own problems. In order to meet the needs of water scarcity, water stress, and the upheaval of attaining freshwater in the central dry zone, the JICA (Japanese

International Development Agency) supports the Project on Rural Water Supply Technology in three townships. The main purpose of the study is to share experience and knowledge with the government and ministries and to provide data for the national water policy and environmentally sustainable policies for water resources projects in Myanmar.

In 2014, The USAID (United States Agency for International Development) and P&G (Procter and Gamble) formed a partnership to improve maternal and child health in Myanmar through joint investments of $2MM and distribution of ten million packets of P&G PUR (Purifier of Water) to produce 100 million liters of clean drinking water. PST (Population Services International) Myanmar, is the implementing NGO for this new public–private partnership for community training activity to use PUR sachets. GRET & Solidarités International (SI), Denmark funded by DANIDA (Denmark International Development Agency) provides an integrated assistance to the vulnerable populations in two areas of Myanmar: Dry Zone and Chin State (2013–2015). This project aims at improving the living conditions of vulnerable populations by an integrated approach tackling water access, hygiene, and livelihoods. The intervention areas include three townships in Dry Zone and one township in Chin State. The project covers the construction of rainwater storage tanks and water supply facilities and installation of domestic rain water systems and community rainwater catchment facilities, establishment of community water user groups, holding training workshops for irrigation, home gardening, accountancy and basic business management, and to conduct survey on social water management. Moreover, current programs focus on emergency water supply and sanitation services for IDPs (internally displaced persons) in Rakhine State and in Southern Kachin State. The innovative water projects in dry zones also focus on crosscutting issues such as gender balance. Phase I Project Impact Assessment conducted during January 2013 found that villagers especially women can save the time used to fetch water and dedicate it to income-generating activities. Women play an active role in Water Management Committees and they are targeted during hygiene promotion sessions as they carry out household chores which entail sanitary risks such as cooking.

The World Bank has supported the project titled: "Myanmar National Community Driven Development Project" (Project ID P132500) being approved in 2012 and aimed to enable poor rural communities for an improved access to and use of basic infrastructure

through a people-centered approach including financing for drinking water systems. A four-year community infrastructure and basic services project (2014–2018) supported by the Japan Fund for Poverty Reduction and administered by the ADB (Asian Development Bank) aimed to reduce the prevalence of infectious diseases, to improve the system of solid and liquid wastes disposal, and to reduce flooding and water logging in two of the most populous cities. This will help ensure improvements such as better access to safe and regular water supply, sanitation, drainage, and flood protection are sustainable.

UNICEF is extending clean water, environmental sanitation, and hygiene services to disadvantaged communities in Rakhine State to protect children's health. There is a construction of clean water supply systems in 77 schools and 35 communities, contributing to broader efforts that have increased the proportion of schools providing safe water to their students from 6 percent to 52 percent in three years. The community-led total sanitation project implemented by Department of Health is scaled up in several townships of Myanmar to increase children's access to safe drinking water and sanitary facilities. Two projects namely ICDP (Integrated Community Development Project) and the CDRT (Community Development for Remote Townships Project) supported by UNDP (United Nations Development Program) (2013–2015) help communities to get a reliable supply of safe drinking water by upgrading existing water supply systems or by introducing new ones.

Stockholm Environment Institute (SEI): The Asia Center has signed an agreement with Department of Water Resources and Improvement of River Systems to support participatory water resources planning and assessment in the Ayeyarwady River Basin. The program is led by SEI in collaboration with partners from Myanmar and other Mekong Region countries, financed by the Blue Moon Fund foundation and SEI core funds.

There are small-scale provisions of clean water by nongovernmental organizations, communities, and entrepreneurs. In Dedaye Township, Ayeyarwady Delta Region, one pilot project in 2011 used hydrogen peroxide and silver to treat contaminated pond water through vendors. Myanmar Red Cross Society operates in WaSH sector focusing humanitarian aids while Rotary Myanmar works with water systems for orphanages. Parami Energy Group in Myanmar founded in 2004 has also responded to flood and fire victims and is working to increase access to clean drinking water by building wells, and helping medical facilities and schools in developing consistent access to clean water.

Interview with Dr. Khin Maung Lwin, Member of the Global Steering Committee of the Water and Sanitation Collaborative Council, Geneva

Dr. Khin Maung Lwin served for 34 years with the Myanmar Ministry of Health and was the National Health Promotion Program Director in 2010 at the time of his retirement. He is a consultant to the Asian Development Bank on Urban Development and Water Supply in Yangon, Mandalay, and other regions. As an Expert Member and a Theme Group Leader for "Water for People and Environment" he is currently assisting the National Water Resources Committee of Myanmar.

Describe the current water situation in your country in terms of health, access, and scarcity.
Myanmar is one of the top countries in the region in terms of high infant mortality rate and waterborne and water related diseases. Water scarcity has also added more problems causing an unhygienic environment that leads to increased neonatal deaths. Available data indicates that (80 percent) of the population gets access to safer water but the real situation is the reverse. There is an imbalance in the availability of water in Myanmar and there is poor quality water all over the country. Some spots in the dry zone have scarcity the whole year round and many areas have this problem during the summer time, including the delta areas and coastal areas. Amid rich water resources, Myanmar has poor water quality for both drinking and domestic usage.

What are the major waterborne diseases in your country/and or region?
Diarrheal Diseases are the most common. Many deaths are due to severe diarrhea and the causal agents include Cholera and Enterovirus. Typhoid, Dysentery, and Hepatitis are also common. Polio wild virus is still detected though Myanmar has an impressive campaign on polio immunization. After the Nargis Cyclone, there were some Leptospirosis cases among victims. Water-related diseases such as Dengue, Malaria, and Elephantiasis due to different species of mosquitoes and the emerging Chickungunia and Japanese Encephalitis has been detected recently. Trachoma is common in the dry zones due to the lack of water for hygiene and Scabies is spreading in recent decades.

What are the significant barriers to water health and access?
Two strong barriers reduce access to water for health. First, people's behavior from source to mouth determines the quality of water for both drinking and domestic use. Second, the existing infrastructure fails to enable water for health due to poor water governance, sector-wise water resources management, a lack of legal support for proper water financing and related institutions with an old mindset and old tools.

Describe any groups or minorities that face specific hardship regarding water access and health.
As Myanmar is one of the LDC countries, the following groups suffer the most:

1. Children under five
2. The elderly
3. People living in remote areas
4. Ethnic minorities
5. Migrants
6. The urban poor.

What is being done to assist these groups at the national or local government level?
Ministries representing the national government organized various programs and projects to provide water for drinking and domestic usage, water for agriculture and livestock, and water for industries using sector-wise approaches and regulations. State and regional governments are also playing supportive roles to the union government and will have more autonomy in the near future on water rights.

What policies is the national government developing or conducting to expand water/sanitation health and access?
The National Water Policy was endorsed by the president in February, 2014. Its objective is to take cognizance of the existing situation, to propose a framework of creation of a system of laws and institutions, and for a plan of action with a unified national perspective including the Myanmar National Water Framework Directive.

What policies would you like to see the national government introduce to improve water/sanitation access, quality, and health?
Future policies on Good Water Governance, Integrated Water Resources Management, Corporatization or Privatization of Waste Water Treatment, Solid Waste Management and Sewerage Systems and Blue Economy should be developed and implemented.

Describe particular challenges facing vulnerable and minority children with respect to water access and health.
There are multiple challenges facing vulnerable children. From birth, many children get contaminated water in addition to breast milk. They have to grow up drinking low-quality water while the elderly people take boiled water with green tea that the children find difficult to drink. According to some studies, 9 out of 10 people in this country use unsafe water for domestic purposes. Stream and river water are widely used for washing, bathing, cleaning vegetables, and dishes. Unhygienic practices add more problems for the children not only in the household but also in the nurseries, primary schools, and the environment.

What environmental problems are impacting water quality?
Unhygienic handling of drinking water from source to mouth is the major problem. Due to uncontrolled development, many water sources became contaminated with bacterial, chemical and other pollutants. There are so-called Industrial Zones discharging effluent with very high BOD (Biochemical Oxygen Demand) and COD (Chemical Oxygen Demand). At the same time, the rivers have high TSS (Total Suspended Solids) and heavy metals due to mining. Herbicides, pesticides, and chemical fertilizers from the agriculture sector are contaminating water sources that local residents thought was safe and have used for generations. EIA (Environmental Impact Assessment), HIA (Health Impact Assessment), and EMP (Environmental Management Plan) were introduced recently but it will take a long time to get back the safe water for the people.

What are the three major steps that could be taken in the future to improve the general water health and access situation?
First, develop a National Water Legal Framework.
Second, capacity building for water stakeholders.
Third, pro-poor plans for safe and adequate water.

Describe two or three innovative water development or rights projects that are benefiting people.
First, communication for behavior change on water rights. Second, community-operated water projects.

How important are the local NGOs and the international NGOs in protecting and advancing water rights and development in your country?
Some INGOs and NGOs are actively participating in the water sector in various themes mainly on water supply, household disinfection, and latrine construction. They are involved in communicating with people in their service areas on proper utilization of water sources and maintenance. They should be encouraged to play the role of water quality monitors and water rights protectors. Their roles on wastewater control and environmental conservation need to be established. Networks should be formed to facilitate integrated management and resource sharing.

Describe your own background and water-related work and development.
I am the founder of the "Four Cleans Project" in this country since 1985. Clean water, clean food, clean hands, and clean toilets are the focused actions for the community-based health promotion programs jointly organized by the Ministry of Health and UNICEF. After 34 years of service, I retired as a national health promotion program director in 2010. I am now serving as an elected member of the Global Steering Committee of the Water Supply and Sanitation Collaborative Council based in Geneva that is affiliated to the United Nations and organizing projects related to the Global Sanitation Fund. I am also playing the role of a consultant to the Asian Development Bank on Urban Development and Water Supply in Yangon, Mandalay, and other regions. As an expert member and a theme group leader for "Water for People and Environment" I am assisting the National Water Resources Committee chaired by the vice-president of the union government.

Describe the importance of improved sanitation systems for health and water safety in your country or province.
Myanmar has only one sewerage system built by the British more than 100 years ago and updated as a treatment plant for a small part of Yangon. During the past two decades, many industrial zones were created without treatment plants and sewerage systems. Treatment for

the drinking water supply system is also negligible. Solid waste disposal is by traditional dumping grounds. Waste is directly disposed to the nearby water sources. Efforts on sanitary latrine construction have impressive returns. However, the political level has reduced the goal to supply only one-third of the population. These points are the reasons for giving priority to improved sanitation.

Describe the major priorities in your own work and/or NGO work you will be associated with for the next five years.
To get the Myanmar Water Act and establish the Rule of Law in the WaSH sector should be the top priority. The stakeholders should find the way to have IWRM successfully implemented by practicing Good Water Governance. The country must have a Strategic Plan for Climate Change Resilience for the coming five years.

Additional Comments
As one of the least developed countries, we are expecting support from the richer global community on facing climate-change issues. We hope that the conference on climate change in Paris in 2015 could find solutions for funding (100) billion USD as committed previously.

CHAPTER TWO

Cambodia: A Rural Water Crisis

Country Overview

Cambodia is one of the least-developed countries in the world and the poorest in Southeast Asia, which hinders progress on a range of important human development and water security issues. The Human Development Index (HDI) is calculated annually by the United Nations Development Program (UNDP) and published in the annual Human Development Report. It ranks 185 countries out of 193 UN member states. Eight countries are not included due to a lack of data. The low ranking of Cambodia at 138 reflects systemic issues of poverty that impact crucial development in numerous areas including water security. In 2012, 20.5 percent of the population was living below the poverty line and approximately 79.8 percent were rural citizens. In general, water and sanitation access in the country is unstable and inadequate for millions of citizens. Since water security is closely related to sanitation and health, these deficiencies pose significant challenges for the government.

Cambodia is a predominantly rural country with heavy dependence upon agriculture and great reliance on foreign governments and NGO (nongovernmental organization) assistance. In 2013, according to the WHO (World Health Organization) and UNICEF (United Nations Children's Fund), 90 percent of the urban residents and 61 percent of the rural residents had an improved source of drinking water. It is important to note however that the term "improved source of drinking water" can be misleading due to constantly rising pollution, mishandling of water sources, leakage, and contaminants that are not regularly monitored in the water supply. It is also evident that dangerous chemicals such

as arsenic, which have been identified in some Cambodian drinking water sources, are difficult to detect without sophisticated analysis that in many cases is beyond the financial capacity of many communities and health department budgets. Although water and sanitation access shows signs of improvement in the urban areas, it is rudimentary in many rural areas where 79.8 percent of the population reside. Although water supply in the country is abundant, the overriding problem is one of infrastructure, quality, and access by the population.

Major health, economic, and water indicators

Human Development Index for Cambodia, 2014: 136
Population, 2014: 15.14 million
Gross national income (GNI), 2012: USD 838.00
Life expectancy, 2012: Female: 65.0
Male: 62.2
Improved rural water source, 2012: 66 percent
2010: 61 percent
Population percentage with access to improved sanitation, 2013: 31 percent
global average: 72 percent
Rural population, 2012: 79.8 percent
Poverty index, 2011: 20.5 percent
2010: 22.1 percent
Homeless population, 2014: 2.225 percent
Carbon dioxide emissions per capita (tons), 2014: 0.29

Cambodia is located in Southeast Asia along the Gulf of Thailand coast and shares the important Mekong River basin with Thailand, Laos, Vietnam, Myanmar, and China. Approximately five million people are dependent upon agriculture for their livelihood yet subsistence farming is common at low-income levels. The main crop is rice and exports have surged in the 2010–2015 period. Rice production utilizes an estimated 2.3 million hectares or 85 percent of the nation's total cultivated area. Water quality, irrigation, and climate change are major issues that confront the country as a whole and the rural population and agriculture sector in particular.

Phnom Penh: City Water Profile

The capital of Cambodia is Phnom Penh with a population of 1.4 million. It is situated at the confluence of three historic rivers, the Bassac, Mekong, and Tonle Sap, which provide freshwater for the city. Political

upheaval and war have had a devastating impact upon the Cambodian society and on basic services such as health care and water. Until 1970, the inhabitants of Phnom Penh had a stable water supply and safe drinking water. During the later stages of the Vietnam War, the US military launched damaging bombing campaigns against the communist Viet Cong forces who were using a western corridor inside Cambodia to move supplies and soldiers from North to South Vietnam. The fallout from the Vietnam War and the subsequent 1975 invasion and takeover of the country by the Marxist Khmer Rouge guerilla army destroyed significant water infrastructure and supply. In 1975, the Khmer Rouge evacuated Phnom Penh by force and marched the city residents into the countryside to begin an ill-fated agrarian revolution that resulted in a genocide causing an estimated 1.7 million deaths. In 1979, the Vietnamese-Cambodian ongoing border clashes finally led to a Vietnamese invasion, which toppled the Khmer Rouge regime. It took years of slow socioeconomic growth, political reform, and international aid to gradually rebuild the beleaguered country and population. The PPWSA (Phnom Penh Water Supply Authority) was established in 1959 by Royal Decree No. 164NS as a state enterprise under the jurisdiction of the Ministery of Interior and direct supervision of the Phnom Penh Municipality. In 1979, the PPWSA resumed operations at 45 percent of its initial capacity.[1]

The PPWSA launched a major reorganization in 1993. The PPWSA transformed corrupt and inefficient operations to become a successful and effective public utility.

> The utility currently provides uninterrupted clean water service to over 90% of the city of Phnom Penh and has consistently increased its profits since 1993 while also paying consistently higher income taxes to the Cambodian Government and providing subsidies for poor households. Continued success will depend on the ability of the utility to tackle the main threats that affect urban water: population growth, water scarcity, decreasing water quality and pollution, water overuse, climate change, and infrastructure, institutional, and social problems.[2]

The 1993 PPWSA reform process improved performance and operation markedly. Between 1993 and 2008, the PPWSA increased its annual water production by 437 percent, the distribution network by 540 percent, pressure of the system by 1,260 percent, customer base by 662 percent, and the number of metered connections by nearly

5,255 percent. Unaccounted for water was reduced from 72 percent of treated water produced to 6.19 percent. The number of poor households connected to the system steadily increased from 101 to 26,778 between 1999 and 2011.[3] The water supplied by the PPWSA conforms to drinking water quality standards set by the WHO and national drinking water standards. The PPWSA operates three water treatment facilities and tests water quality daily.

Accelerated urban growth and industrialization in and around Phnom Penh have led to increasing demands upon the water system, health care, and other essential city services. Moreover, as with many rapidly developing cities in less-developed countries, people migrate in large numbers to urban centers in search of a better life and opportunities. Such is the case with Phnom Penh. Its population increased from 1.3 million in 2008 to 1.7 million in 2014 and is projected to reach 2.4 million by 2030; meanwhile national population has surged from 9 million in 1990 to 14. 8 million in 2014 and is projected to reach 21.9 million by 2050.[4] The national birth rate has improved from 124 deaths per 1000 live births in 2000 to 54 deaths per 1000 in 2010. Sanitation coverage falls under the responsibility of the Cambodian Public Works and Transport Ministry. It is estimated that 41 to 72 percent of the national population lack access to improved sanitation facilities.[5] "The majority of houses in the city center of Phnom Penh are connected to a combined sewerage system consisting of underground pipes (built mostly in the 1960s) that discharge into main open interceptor sewers. Since there is no wastewater treatment plant in Phnom Penh, the interceptor sewers discharge 10% of effluents directly into the Mekong River without any treatment. The remaining 90%, which amounted to approximately 55,600 m^3/day in 2004, is discharged into three natural treatment wetlands. Although the wetlands have been shown to effectively treat waste, they continue to pose a risk to settlers that grow vegetables in the area. Moreover, filling-in of the natural wetlands to provide land for new development in the city began in 2010, which could have significant impacts in local flooding, water quality, and capability of treating waste."[6] "The inhabitants of Phnom Penh that don't have sewer connections usually have septic tanks that are emptied by private operators. The situation is much different in poor settlements where residents use public toilets, open pits that are shared by multiple families, or defecate into water. As a result of the lack of city-wide sanitation coverage and wastewater treatment, water supplies in Phnom Penh have been shown to be polluted with bacteria or chemical contamination."[7]

Unfortunately, like many large cities in the developing world, rapid growth in Phnom Penh has been accompanied by the growth of slums that expand along with population acceleration. As the city population increases, more people are driven by poverty to live in slums, thus placing an even greater strain on services that are already minimal and substandard. The number of slum dwellers in Phnom Penh grew by 25 percent between 1994 and 2014 to more than 105,000 and 511 slum settlements according to recent government reports. Between 2012 and 2014, the number of slum dwellers rose by about 20,000. The slums are beset by a range of health, social, and economic problems that render life difficult and dangerous. These problems include inadequate water supply, improper sanitation systems, high crime rates, overcrowding, unhygienic conditions, higher levels of disease, pollution, poor air quality, unstable and substandard housing, and high unemployment. A report on Phnom Penh slum conditions by MIT researchers noted the following conditions:

> The most common kinds of sickness in the settlements surveyed are diarrhea (20.5%), fever (19.5%), and cold (16.3%) mostly due to the low quality of water and the unsanitary living conditions. The average cost of an illness is 22,000 Riels, which represents almost ten weeks of savings. People finance their health cost in majority by borrowing from family (35.7%), from neighbors (33%), or from private money lenders (15%). Only 12% had enough saving to finance the last sickness in the family. They purchase water from private sellers who have official connections, or who pump water from the river. Water is often of low quality, and always proportionally more expensive than for someone with an official connection to the public network. A cubic meter of water privately purchased costs 1,000 to 10,000 Riels, while it costs 350 to 700 Riels from the public network. Because of this high cost, the poorest often use surface water from the rivers or boengs. They often fall sick because of its low quality.[8]

Health and Human Rights Challenges

With a high rate of extreme poverty and rural underdevelopment, it is inevitable that Cambodia will face substantial health problems in the years to come. Severe levels of income inequality exist between the urban and the rural communities. Moreover, extreme poverty is a

leading contributing factor to water insecurity and waterborne disease enhanced risk factors. In 2011, the use of improved drinking water sources was 89.6 percent in the urban areas and 66.1 percent in the rural areas, while access to improved sanitation facilities was 76.4 percent in the urban areas and 22 percent in the rural areas. This substantial gap between urban–rural water and sanitation coverage dramatically highlights the glaring development gap in the country. The risk of infectious diseases in Cambodia is very high. Food and waterborne diseases include bacterial and protozoal diarrhea, hepatitis A and typhoid fever; VBDs (vector-borne diseases) include dengue fever, malaria, and Japanese encephalitis. High rates of dysentery, which is a common waterborne disease, is also evident. Water collection and storage facilities in the rural areas are often rudimentary thus exposing inhabitants to illness and disease. According to a report by the Cambodian Ministry of Water Resources and Meteorology, "domestic water supply and sanitation is at a low level in Cambodia, except in the capital city. Rural water supply is in many villages dependent on streams, open ponds and shallow wells, which constitute a health hazard. Water supply systems in the 20 towns that had them have deteriorated to a very poor state, with low coverage (maybe 10% of households in a town), short periods of supply (a few hours a day), and water that is not potable without boiling. Urban wastewater treatment is largely absent in Cambodia, except for primary (lagoon) treatment of some sewerage in Phnom Penh, a small plant at Battambong, and planned investment in Siem Reap and Kampong Som. An expected doubling of urban population by 2030 will greatly increase pollutant loadings on rivers, unless there is large scale investment (e.g., $300 m to rehabilitate Phnom Penh's sewerage system). Private sector involvement in urban water supply and sanitation requires that companies can be sure of profitability, within a regulatory environment that protects both public and private interests."[9] Among the ASEAN (Association of Southeast Asian Nations), Cambodia has the lowest access to rural sanitation facilities and the second lowest access to safe water in rural areas. Due to the high poverty rate in the rural communities, there is a substantially higher rate of water-related disease and sanitation-related illness. "Among households in the poorest quintile, only 48% (during dry season) and 39% (during wet season) have access to improved water sources, whereas 70% (dry season) and 64% (wet season) of the richest quintile have such access. Access to improved water also varies across provinces. In Koh Kong and Svay Rieng, at least 90% of households

have access during the wet season, while those in Kep, Mondulkiri, and Rattanakiri have access rates below 15% of households."[10]

It is important to recognize that the effects of poverty go far beyond apparent benchmarks such as income and housing. A wide range of necessary needs are not met due to poverty. This is the central point of capability deprivation that the noted academic and Nobel laureate Amartya Sen has elaborated. Poverty affects physical health, mental health, water access, water quality, schooling, employment options, housing choices and options, nutrition levels, life expectancy, mobility, and many other indicators that are essential to a healthy and adequate standard of living. Moreover, poverty also deprives people of future opportunities for growth and development in socioeconomic terms. "In rural Cambodia, millions of citizens cannot afford adequate water nor safe sanitation systems. In 2013, just over 98% of households in Phnom Penh had improved toilets, compared with only 40% in rural areas. Open defecation remains common among 56% of rural households. Toilet facilities are accessible to only 29% of people in the poorest income quintile versus 79% in the richest quintile. Male-headed households are more likely to have access to improved sanitation than households headed by women. Sanitation coverage also varies across provinces."[11] Despite progress on improved drinking water sources in the country, quality gaps remain which jeopardize health. These health problems can be particularly acute for children who do not yet have a fully developed immune system. Children living in poverty are further compromised because they have developed without adequate health and nutrition levels that exposes them to increased levels of illness and disease. According to estimates, 39 percent of the rural population of the country uses unimproved drinking water sources and the danger of this is manifested in the kingdom's high infant mortality rate of 82 per 1000 live births and 56.2 percent of post-neonatal deaths. In Cambodia, the onset of diarrheal disease caused by the consumption of unhealthy water is the number one cause of death in children under the age of five.[12]

An assessment program conducted by the University of Alabama on water quality in rural Cambodia identified substantial health problems. The study focused on a targeted region of Kampong Speu Province. The area is close to Phnom Penh yet deficient in water quality of the same standard. Cambodians in this province typically utilize water stored in ponds or both protected and unprotected wells. The two measurements that the study analyzed to determine the quality of

selected water sources were TTC (thermo-tolerant coliform) bacteria and arsenic. The study noted the following conclusions:

> TTC is a bacterial indicator of waterborne fecal contamination. Arsenic is an emerging problem found in groundwater sources in Southeast Asia, particularly in the Mekong delta region, and is naturally occurring. The World Health Organization states that TTC should not be detectable in any 100 mL sample of water, and the level of arsenic must be below 10 ppb in order for the sample to be considered safe to drink. Since 49.3% of Cambodia's rural population relies on unprotected ponds, streams, rivers, or wells for drinking water treatment is usually required to make water safe. Centralized treatment facilities have not been established in rural Cambodia. Each site is different but in general the conclusion drawn from the survey is that rural Cambodians do not have access to clean drinking water unless they venture to filter it themselves. Of the 22 drinking water sources only two of the sites met the WHO standard for safe drinking water of 0 TTC colony forming units (cfu)/100 mL, and one sample was within the threshold of moderate risk (11–100 cfu/100 mL). All other samples (19 of 22) were classified as high risk sources (>100 cfu/100 mL) should they be consumed untreated. Only one of the five wells with available TTC data met WHO standards.[13]

Water shortages are a common experience in the country. According to government reports: 81 percent of households interviewed suffered from water shortages for agricultural uses, while 54 percent suffered from water shortages for personal uses. Although villagers have traditionally coped with drought in a variety of ways, there appear to be serious limits to the extent to which people may adapt. Thus, 24 percent of villagers interviewed simply organize religious ceremonies in the hope that these will bring rain. Approximately 16 percent of the survey respondents plant crops as usual, again hoping that there will be enough rain for agriculture. Some 17 percent of households reduce water consumption: for instance, limiting bathing to a few times a week; or just wiping oneself with a wet cloth instead of taking a full bath. In about 26 percent of cases, malaria was contracted while cultivating chamkar, or agricultural fields. This compares to 28 percent of cases while logging in the forest, and 18 percent while staying at home. Almost 63 percent of households contracted malaria during the

wet season, 12 percent during the dry season, and 8 percent in both seasons.[14]

Arsenic in Water

The emergence of arsenic as a health problem in Cambodia has caused users to alter water consumption patterns where possible. The identification of the health detriments of arsenic in water sources has been a relatively recent area of focus in the developing countries of Southeast Asia. Moreover, it is a problematic health issue because persons suffering from arsenic contamination normally do not become symptomatic for 10–15 years. Diagnosis requires sophisticated medical testing, which in many cases is beyond the capacity of rural health clinics in impoverished regions. A recent study on arsenic contamination in Cambodia examined the health impacts of arsenic and other toxic trace elements in well water, groundwater, and hair samples that were collected from three areas with different arsenic exposure levels in the Mekong River basin of Cambodia. The locales included the Ampil commune in Kampong Cham province which was identified as an uncontaminated area, the Khsarch Andaet commune in Kratie province which was identified as a moderately contaminated area, and the Kampong Kong commune in Kandal Province which was classified as a severely contaminated area. According to the study, "out of 46 observed wells in the Kandal province study area, 100% detected As > 50 μg L(–1) and Fe > 300 μg L(-1); 52.17% had Mn > 400 μg L(-1) and 73.91% found Ba > 700 μg L(-1). In the Kratie province study area (n = 12), 25% of wells showed elevated arsenic levels above 10 μg L(-1) and 25% had Mn > 400 μg L(-1), whereas samples from Kampong Cham province study area (n = 18) were relatively clean, with As < 10 μg L(-1). The calculations also indicated that, in the Kratie province study area, 13.48% of respondents were affected by non-cancer health risks and 33.71% were threatened by cancer, whereas none of respondents in the Kampong Cham province study area appeared to have non-carcinogenic effect. Positively significant correlations of the arsenic content in scalp hair (As(h)) with both arsenic levels in groundwater (As(w)) ($r(s)\ (304) = 0.757$, $p < 0.0001$) and individual average daily doses (ADD) of arsenic ($r(s)\ (304) = 0.763$, $p < 0.0001$) undoubtedly indicated that arsenic accumulation in the bodies of Cambodia residents in the Mekong River basin was mainly through a groundwater drinking pathway. This study indicates that elevated arsenic concentrations in groundwater may lead to thousands

of cases of arsenicosis in the near future if mitigating actions are not taken."[15]

Another study conducted by South Korean researchers noted significant levels of arsenic contamination in Vietnam, Cambodia, and the Lao People's Democratic Republic. "Most groundwater used as a source of drinking water in rural areas has been found to be contaminated with arsenic exceeding the WHO drinking water guideline of 10 μg·L(–1). With the exception of Thailand, groundwater was found to be contaminated with naturally occurring arsenic in the region. Interestingly, high arsenic concentrations (>10 μg·L(-1)) were generally found in the floodplain areas located along the Mekong River."[16] Research conducted by the Swiss Federal Institute of Aquatic Science and Technology concluded that the "population at risk of chronic arsenic poisoning is estimated to be 10 million in the Red River delta and 0.5–1 million in the Mekong delta. A subset of hair samples collected in Vietnam and Cambodia from residents drinking groundwater with arsenic levels >50 μg/L have a significantly higher arsenic content than control groups (<50 μg/L)."[17] As these and other findings indicate, the levels of human arsenic poisoning in Laos could very well lead to abnormally high cancer rates in the near future.

Environmental Challenges

Climate Change

Cambodia is extremely vulnerable to climate change. Common outcomes include flooding, increased surface temperatures and sea levels, greater frequency of extreme weather, episodes of drought, increased illness such as VBDs. These all have negative impacts upon health. Since Cambodia is primarily an agricultural country, flooding is a serious risk to development in this sector aside from the health and water quality implications. The monsoon season generally lasts from May to October and accounts for about 80 percent of annual rainfall. The dry and cooler season lasts from November to April. A Cambodian government report on the impact of climate enumerated dire consequences. "Climate hazards occurring in Cambodia include flood, drought and windstorms. In coastal areas, underground water salinization, and seawater intrusion are common problems. The occurrence of drought and flood is widespread in Cambodia, which are recognized as the main contributors of poverty. The severe floods that occurred from 2000 to 2002 resulted in 438 casualties and caused damages amounting to US

$205 million. A total of 684 households in 17 provinces were surveyed for the following climatic hazards: flood, drought, windstorm, seawater intrusion and high tide. Without exception, all 17 provinces surveyed have suffered from both floods and droughts. Seawater intrusion was reported in all three coastal provinces, while high tide was recorded only in two coastal provinces. Villagers cite flood and drought as the most severe climate hazards in all 17 provinces surveyed."[18]

Climate change will have significant impacts on agricultural production, fisheries, poverty, groundwater recharge and viability, and surface water availability, quality, and distribution. One of the major challenges for the city of Phnom Penh and the PPWSA will be changes in seasonality and the volume of flow in the Mekong River, which would increase flooding in the wet season and cause water shortages during the dry season.[19] Flooding and agricultural damage from climate change will dramatically impact food security. Recent events serve as a forewarning of the impending challenges. In 2000, catastrophic flooding hit 84 districts and 595 communes around the Great Lake and the Mekong River that resulted in damages totaling USD 145 million. The devastating 2002 drought hit eight provinces with a population of 1.5 million people. Cambodia's population and economy are clearly vulnerable to climate change. Over 65 percent of Cambodia's population is economically reliant upon agriculture. According to the Cambodian governments own report on climate change, most farmers are not prepared or equipped to adapt. Moreover, recent studies suggest that for poor agrarian households, "negative productivity shocks can simultaneously decrease farm income and increase food prices, leading to severe decreases in real income that can threaten the livelihood of current and future generations. This phenomenon was evidenced by the fact that half of Cambodian households reduced food consumption during the 2008 food price crisis. Projections indicate that under all climate and overall scenarios the cultivated area of rice will decrease by over 20 percent from 2010 to 2050. Current estimates indicate that there are 3.6 million malnourished in Cambodia, and 27.5 million malnourished in Mainland Southeast Asia."[20]

The government climate change report noted that "villagers were asked to share their experiences of dealing with floods and to describe existing ways to adapt to floods. Almost 20% of villagers interviewed did not make any preparations for flood at all. About 17% just planted their crops as usual. Traditional adaptation measures include building elevated enclosures for livestock, increasing the household's food stock, increasing feedstock for animals, and preparing boats. An insignificant

number of households interviewed moved to a safer place in anticipation of floods."[21] An indication of the devastation wrought by flooding is the fact that between 1998 and 2002, floods were responsible for 70 percent of rice production losses. As the effects of climate change accelerate in Cambodia, the socioeconomic losses will be a severe burden for a country that is already the poorest in Southeast Asia.

Another devastating implication of climate change involves health. Dengue fever, which is currently categorized as high risk in Cambodia, is expected to rise due to the effects of climate change. "Priority VBDs in Cambodia include dengue, which typically occurs in urban or peri-urban areas, and malaria which is more commonly rural and found in proximity to forested areas. Dengue cases have been increasing over recent years, with severe outbreaks occurring in 3–4 year cycles, predominantly during the rainy season. In Cambodia, the primary dengue vector is the household-associated mosquito Aedes aegypti . Ae. aegypti breeds predominantly in large, concrete, household-associated containers used for storage of water for domestic use. This relationship with human water storage and sanitation practices makes the disease particularly vulnerable to the effects of climate change including as a consequence of unplanned urbanization and household-associated water storage and drought."[22]

VBDs are common in Southeast Asia and include malaria, dengue fever, lymphatic filariasis, plague, tick-borne encephalitis, and Lyme disease that are transmitted to humans by the bites of infected arthropod vectors including mosquitoes, fleas, and ticks. In Asia, VBDs cause widespread disease burden and human suffering. According to the WHO, VBDs transmitted by mosquito vectors cause the most disease. "WHO has received reports of over 200,000 cases each of dengue and malaria annually in the 5 years from 2007 to 2011. Lymphatic filariasis remains endemic in 22 WPR countries and emerging diseases such as chikungunya and West Nile are causing concern. It has been known since the early 20th century that climate is a determinant of the distribution of VBDs: warming of the environment expands the theoretical range of vectors, increases their reproductive rate and season, results in more frequent feeding and shortens the maturation time of pathogens they transmit."[23]

The Mekong River

The Mekong River is a paramount economic, transport, and water supply source for the people of Cambodia. Originating in the historic

Tibetan Plateau, the river traverses six countries including China, Myanmar, Thailand, Laos, Vietnam, and Cambodia. It is the longest river in Southeast Asia and twelfth longest in the world. About 85 percent of Cambodians depend upon the river to meet their water needs for agriculture, industry transport, and household use. The United Nations, UNICEF, and many NGOs have cited concerns over the level of arsenic contamination in the river. According to reports from WEPA (Water Environment Partnership in Asia), the water environment of the Mekong River is increasingly subject to chemical dumping and sewage. "The living environment, especially human health, is affected by the discharge of untreated and low quality treated wastewater into receiving waters. The existing storm drainage system is also used for sewage collection and conveyance. The waste from these septic tanks flow into the storm drainage system for discharge into receiving waters without any treatment, thereby creating potential environmental pollution problems. In fact, there are reports that it is already causing growing pollution in the Mekong River and other main water bodies."[24]

Moreover, a Swiss study has reported significantly high levels of arsenic contamination in the Mekong River and Mekong River Delta. According to the study, "the population at risk of chronic arsenic poisoning is estimated to be 10 million in the Red River delta and 0.5–1 million in the Mekong delta. A subset of hair samples collected in Vietnam and Cambodia from residents drinking groundwater with arsenic levels >50 μg/L have a significantly higher arsenic content than control groups (<50 μg/L)."[25] The Mekong River is an abundant source of fish for millions of Cambodians. Cambodia is a high fish consumption society. Yet recent reports are showing increasing levels of mercury contamination that is a growing health threat and is damaging to fish stocks. Cambodia ranked fourth among the world's top freshwater capture fisheries, with fish providing up to 75 percent of all animal protein for rural Cambodians, much on the strength of the Mekong River and its tributaries including the TonIe Sap Lake. [26] There are several significant water quality issues in Cambodia ranging from basic sanitation, to arsenic contamination in drinking water wells, to improper pesticide practice, to mercury contamination moreover, the levels of mercury in fish and human hair, particularly along the Mekong River corridor, were sufficiently high according to a 2009 study that more detailed assessments were recommended.[27]

These findings have also been corroborated by Japanese researchers in a study which examined mercury contamination in human hair and fish. Mercury (Hg) concentrations in human hair and fish samples from Phnom Penh, Kien Svay, Tomnup Rolork and Batrong, Cambodia, were collected in November 1999 and December 2000 and analyzed to determine the intake of mercury through fish consumption. According to the study, "mercury concentrations in human hair ranged from 0.54 to 190 mug/g dry wt. About 3% of the samples contained Hg levels exceeding the observed adverse effects level (NOAEL) of WHO (50 mug/g) and the levels in some hair samples of women also exceeded the NOAEL (10 mug/g) associated with fetus neurotoxicity. Three samples of marine fish including sharp-tooth snapper and obtuse barracuda, and one sample of sharp-tooth snapper exceeded the guidelines by US EPA and by Joint FAO/WHO Expert Committee on Food Additives (JECFA), respectively, which indicates that some fish specimens examined (9% and 3% for US EPA and JECFA guidelines, respectively) were hazardous for consumption at the ingestion rate of Cambodian people (32.6 g/day). It is suggested that fish is probably the main source of Hg for Cambodian people."[28]

Government Water Policy and Laws

Although Cambodia has abundant water sources, access and quality are major challenges, particularly for the rural poor and the urban slum dwellers. The government has achieved some measurable progress in instituting a water rights and development framework through policy and law, however implementation and enforcement is slow. After the important Rio Summit, the government of Cambodia established the MOE (Ministry of the Environment) in 1993 and in 1996 instituted the Law on Environmental Protection and Natural Resources Management. The MOE is responsible for environmental planning and the monitoring of pollutants into natural waterways and storm water drains. The government established targets for 2015 based on the Millennium Development Goals to improve access to water and sanitation. These include:

(1) Improved access to water supply: 2015 Urban Target 80 percent
(2) Improved access to water supply: 2015 Rural Target 50 percent
(3) Improved access to sanitation: 2015 Urban Target 74 percent
(4) Improved access to sanitation: 2015 Rural Target 30 percent

Other significant water and sanitation policy developments include:

1995: Agreement on Cooperation for the Sustainable Development of the Mekong River Basin
2003: National Policy on Water Supply and Sanitation
2004: Formulation of a comprehensive National Water Resources Policy
2004: Drinking water quality standards established
2006: Water Users Organizations and Farmer Water User Committees established
2006–2010: Integration of IWRM (Integrated Water Resources Management) in the 5-Year Strategic Development Plan
2007: The Cambodian Water Law passed by the National Assembly for support in strategic investments in the development of water resources
2009–2013: Integration of the IWRM in the NSDP (National Strategic Development Plan)

A Water Development Project Profile

Country Case Study: Cambodian Vector-Borne Disease Cases Expanding
Cambodia is one of the most vulnerable countries in South-East Asia to the effects of climate change, and has limited adaptive capacity to respond. The country experiences seasonal dengue outbreaks, with most cases reported in the summer rainy season. Dengue is historically an urban disease, transmitted by Aedes mosquitoes, but more and more cases are being reported in the rural locations. In recent years, every province has been affected. Climate change and the indirect human responses to it, such as the increased storage of water near households in which mosquito vectors can breed, has been identified in vulnerability analyses as risks that may be contributing to this expansion. A Korean International Cooperation Agency (KOICA)-funded project has addressed these risks through support of a targeted climate change and VBDs health adaption project in vulnerable areas. Disease surveillance systems have been strengthened and the project supported repeated vector mosquito surveys to determine their seasonal and geographical distributions of vector species. Additionally, community-based activities raised awareness in vulnerable population groups and research was conducted into the causes of diseases, including a review of historical records. With the help of experts, this project has initiated

climate change and health adaptation activities in Cambodia in a tangible, practical, and relevant form.

As a result, health workers and the population in vulnerable communities are aware of climate change and VBD risks and response strategies. These have been incorporated into national policies and frameworks for action. Climate data are being included into surveillance systems to monitor trends and identify determinants of disease. An historical analysis—the first step in establishment of a climate-based early warning system—has been conducted. Most importantly, populations and health staff in areas deemed most vulnerable have been provided with information and resources to protect their communities and themselves from the risk of VBD infections and outbreaks (Source: WHO, 2012).

Interview with Sim Saora

Mr. Sim Saora, a Cambodian by birth, obtained his MA in Development Management after completing his BA in English Literature and Social Science. He has had a wealth of direct experiences in the WaSH (Water and Sanitation Hygiene) sector through many years of his work as a WaSH Technical Officer at World Vision and WaSH M and E Coordinator at Plan International. In his functions, he coordinated and collaborated with project partners including local authorities, community people, and donors in making sure that the WaSH projects were properly designed and carried out effectively and efficiently as planned. He currently works with CWS as a WaSH TRC Manager. His main responsibility is to supervise the WaSH Training Resource Center staff and manage the effective implementation of Wash Center activities in compliance with policies, guidelines, ministries, and donor requirements.

Describe the current water situation in your country in terms of health, access, and scarcity.

Over the last decade, there has been significant progress in providing improved water supply and sanitation systems to the rural population in Cambodia. They have, however, not been able to provide safe water according to the national water drinking guidelines. The failure of water and sanitation projects is partly due to insufficient water, hygiene, and sanitation (WaSH) capacity within the country and a lack of technical support to meet the population's needs.

Nearly half of the Cambodian population does not have access to safe water and basic sanitation. Some 6.3 million out of 14.9 million Cambodians are unable to access clean drinking water, most of them poor and living in rural areas. In fact, the WHO statistics show that, only 23 percent of households have drinking water that meets water quality standards for *E. coli*. Cambodia still ranks well below the Western Pacific regional average for access to improved drinking water sources and improved sanitation. Currently, about 40 percent of primary schools and 35 percent of health centers do not have safe drinking water facilities.

Disparities in access to water and sanitation between the urban and the rural areas, across and within provinces, and among different wealth groups are clear. People living in the urban areas of the country have three times more access to sanitation than those living in the rural and the peri-urban areas, diarrhea prevalence is five times greater in some regions than others, and the rich have 22 times more access to piped water than the poor. Too many children are still denied the most basic right to safe water, the dignity of using a toilet, and the simple practice of washing hands with soap. The waterborne and excreta-related diseases cast a shadow over child health and in many cases, result in death.

What are the major waterborne diseases in your country and/or region where you operate?

Major water and sanitation-related diseases in Cambodia include: diarrhea, skin diseases, respiratory illnesses such as pneumonia, intestinal, and worm infections.

What are the significant barriers to water quality, health, and access and what is the 10-year and 25-year outlook?

Significant barriers:

Sociocultural issues: Poverty, lack of participation and ownership, and little or no behavioural change form a self-perpetuating cycle.

Technology: There are few options for water supply, particularly in drought-prone areas.

Geographical area: In the high geographical areas the water table is very deep and ground water tables are contaminated by chemical substances such as iron, hardness, and PH. Low geographical areas that are close to rivers and streams are significantly affected by arsenic.

Private sector: The participation of the private sector is limited due to a number of factors, including a lack of access to credit, investment risk, lack of business skills, unfair competition, and a weak regulatory system.
The monitoring system for rural water supply, sanitation, and hygiene does not apply a single standard. This results in difficulties in monitoring. There are few technology options for water supply, in particular, in areas where there are limited water sources.

10-year and 25-year outlook:

Develop mechanisms to enable sustainable provision of rural water supply
Increase financing for provision of rural water supply
Promote and increase sustainable rural water supply services
Promote sustained hygiene behaviour change in relation to rural water supply

Describe any groups or minorities that face specific hardships regarding water access and health.
The majority of people who do not have access to improved water sources are the poorest living in the rural areas. The reasons are:

Limited number of improved water sources such as ring/hand pump wells with cover and platform, limited clean/protected family or community ponds.
Lack or limited knowledge on the effect of unclean water to human's health especially to the vulnerable groups such as children, women in reproductive age, pregnant women, old and sick people.

What is being done at the national or local government level to assist these groups?
Some NGOs in Cambodia have tried to assist these groups to access improved water sources by providing physical input and knowledge. For Church World Service, we have built the capacity of WaSH practitioners through trainings and consultancy services on water-related issues in order for them to transfer the knowledge to the community population. The training is focused on Community Health Promotion, household water treatment options, and water

infrastructure operations and maintenance, followed by on-site technical support on water quality testing and infrastructure construction.

What policies is the national government developing or conducting to expand water/sanitation health and access?
Cambodian Guidelines: Nationally, the following publications of the RGC (Royal Government of Cambodia) provides guidance for Cambodia:

Ministry of Rural Development; Rural Water Supply, Sanitation, and Hygiene Strategy, 2012
National Strategic Plan for Rural Water Supply, Sanitation, and Hygiene, 2014–2025
RGC's Policy for Water Supply and Sanitation sector, including the UN's MDGs for Cambodia, 2003
National Drinking Water Quality Guidelines, 2012
Water and Sanitation Law of Cambodia (This refers mainly to the urban services)

What policies would you like to see the national government introduce to improve water/sanitation access, quality and health?

- Enforcement on no subsidy policy/strategy to create one direction among WaSH actors across Cambodia
- WaSH financing for the poor (equity access)
- Environmental and climate-change impact to WaSH

Describe particular problems facing vulnerable and minority children with respect to water access and health.
Lack of water and sanitation is one of the biggest issues affecting the health of those who live in the countryside, particularly children. Key effects result from the lack of access to clean water and sanitation, stunting from diarrhea-related malnutrition, and life expectancy is reduced. The consequences for children are severe, as high occurrences of diarrhea, skin disease, respiratory illnesses such as pneumonia, intestinal, and other waterborne and excreta-related diseases cast a shadow over child health. High incidences of diarrheal diseases alone account for one-fifth of the deaths of children aged five and under in Cambodia,

and an estimated 10,000 overall deaths annually, largely owing to a lack of sanitation and poor hygiene practices. Diarrhea is the second leading cause of death for children under the age of five in Cambodia.

What environmental problems are impacting water quality?

1. Garbage is thrown into the lakes and rivers by community people, factories, and industrial companies.
2. Gray water flows into the rivers and lakes directly without a treatment system.
3. The use of pesticides/insecticides for agriculture purposes. These practices have harmful effects on neighboring watersheds. Three factors come into play when considering agriculture and human wastes: Pesticides, fertilizers, and the waste produced by our farm animals, and nonexistent sewage disposal systems. When pesticides or fertilizers are applied to crops, there is evident probability that there will be runoff. The excess materials will either run off the land, or seep into the groundwater, with an eventual ending in bodies of water such as lakes, ponds, or streams.

What are the three major steps that could be taken in the future to improve the general water health and access situation?

It is not different from what CWS has been doing which includes awareness raising on environmental sanitation, household water treatment and safe storage, and hygiene promotion among community members together with local authorities, knowledge transferring to both WaSH practitioners (GO and NGO) and communities, water and sanitation infrastructure (physical input) supporting to household families and communities by the government or the NGOs or development partners or private sectors who can provide low-cost services.

Describe two or three innovate water development or rights project that are assisting people.

1. Gravity water flow systems should be considered for the upper land communities.
2. More options for household water treatment and community water treatment with low cost or cheaper price for communities.
3. More improved water source options focused on needs and resources availability such as community ponds or wells.

How important are the local NGOs and the international NGOs in protecting and advancing water rights and development in your country?
In recent years, the rights to water and sanitation have grown from fragmented implications in other rights to explicit rights in themselves. In 2010, the UN General Assembly formally recognised the right to water and sanitation in resolution 64/292, which "acknowledges that clean drinking water and sanitation are integral to the realisation of all human rights."

And in 2010, also, the United Nations Human Rights Council Resolution on human rights and access to safe drinking water and sanitation affirmed "that the right to water and sanitation are part of existing international law. This body has therefore confirmed that these rights are legally binding upon States."

Unfortunately, such rights can be used as a weapon against the very people they are designed to protect. When people are slow attending to their own sanitation, they are accused of infringing the rights of others to good sanitation. This interpretation was never intended by those framing the rights, and it must be avoided by those involved in implementing projects designed to secure the rights.

Gender: In Cambodia, as in many societies, women's views are not systematically represented in decision making. Addressing the distinct priorities of men and women in water supply and sanitation activities improves the quality and sustainability of projects. There is a strong positive link between a focus on women's active participation and project success. The prevalence of waterborne diseases associated with the lack of safe drinking water increases the burden on women. The priority needs of women are the provision of water supply and private toilets close to the house for convenience. While it is commonly known that women and girls are primarily responsible for collecting water, survey findings indicate that men and boys also collect water during the peak dry season when the only source of drinking water supply is further away.

Disability: Disabilities are mutually causative, with disabled people at a disadvantage in earning a living and poor people more exposed to mines and accidents. Overall disability rates of 3 to 5 percent are found in some provinces, and local figures are often much higher. This means that in a

village of 20 households, up to five people may have difficulty in using a standard water point or toilet. Often outsiders do not see these people during short visits, so the problem is not noticed. The main source of care and support for disabled people is usually the family. In order to be sustainable in the long term, interventions should aim to strengthen the capacity of the family to provide as much of this support as possible.

Describe your own background in water-related work and development.
CWS has experience in Water and Sanitation and Integrated Rural Development for more than two decades across various provinces of the country. CWS Cambodia has worked in the target region of Svay Rieng province, near the Cambodia-Vietnam border from 1992 to 2009, Kandal province from 1992 to 2002, Kampong Thom province since 1993 under the direction and support through Phnom Penh Country Office. CWS started a similar project called VBCD (Village Based Community Development) in Preah Vihear in 2007 in partnership with the government PDRD (Provincial Department of Rural Development). These projects have integrated the Water, Sanitation and Hygiene activities.

From 2005 to 2009, CWS Cambodia collaborated with the PDRD in Svay Rieng on a Water and Sanitation Cooperation Project as part of the CWS international Water for All initiative. This initiative focused on access to quality drinking water, environmental sanitation, and health and hygiene awareness, wastewater use, strengthening household water treatment (bio sand filter) and safe storage. The CWS Cambodia Water and Sanitation Cooperation Project has accomplished very successful work in partnership with PDRD, as a result of this initial partnership; this in turn enabled us to come up with our WaSH Cooperation Model. The model is unique; and aims to support the PDRD, complementing the Water and Sanitation Initiative and specifically addresses related targets under the CMDG and is built on the foundation of peace building, a comprehensive and holistic approach. The approach is utilized and replicated at a smaller scale into CWS's Village Based Community Development in Kampong Thom and Preah Vihear province.

In addition, the WaSH cooperation model engages CWS Cambodia, local implementing partners, and government departments to provide peer support to target communities. At the same time, the model draws on the technical knowledge of the CWS Cambodia WaSH Training Resource Center (WaSH TRC) unit with the purpose of building the technical capacity of WaSH practitioners in Cambodia

on all aspects of WaSH enabling them, with community stewardship, to assume responsibility for the project. CWS has been working in partnership with the CAWST (Center for Affordable Water Sanitation Technology), who provide financial and technical support, the center has the capacity to deliver training to WaSH practitioners in Cambodia including the government, the NGOs partners, and the community groups. The training included Effective Facilitation Skills (Training of Trainer), Community Health Promotion, Water Quality Testing, Household Water Treatment and Safe Storage, and bio sand filter project implementation.

What also makes us unique in our Water and Sanitation Projects is our approach to the communities, local government bodies, and supporting organizations. We believe that we need to analyse the project as a whole, looking at issues of capacity building, dealing with corruption and close mentoring, and monitoring of the communities and people involved. We look at the dividers (that which causes the project to fail, i.e., lack of capacity, corruption) and the connectors (that which brings the ideas, groups, and people involved, i.e., gender mainstreaming, peace building, community networks). This enables us to get a global, national, and local view of the issues that arise when we implement our projects, giving us a more informed and holistic approach to our work in the community and among our staff.

Describe the importance of improved sanitation systems for health and water safety in your country or state/province.

The provision of access to improved water supply services and sanitation for the people is very beneficial both in terms of economic and social aspects. Recent studies show that in Cambodia for an investment of 1 USD for sanitation improvement, Cambodia will benefit about 10 USD. In addition, an investment of 1 USD in water supply services would make a return of 8 USD for the national economy. This is the direct benefit for the people and contribution to enhancing the rural people's livelihood. These overall benefits are huge for Cambodia. Given the economic and social benefits, the rural water supply and sanitation sector has helped save a great deal of expenditure for a number of related sectors, such as health and has contributed to achieving many points of the Millennium Development Goals, namely poverty reduction, reduction in diarrhoea, increase in access to education, reduction in infant mortality, and improvement in maternal health care.

Describe the major priorities in your own work for the next five years.

1. Strengthening the capacity of WaSH to the government's staff at the subnational level (PDRD, DORD, CC, and VDC) and key implementers (Local NGOs and Institution).
2. Improve coordination and communication between key implementers (networking, sharing lessons learnt).
3. Integrate WaSH with other sectors such as agriculture and nutrition in order to decrease the high stunting rate.
4. Engage the private sector more to invest in WaSH services.
5. Generate income from implementing WaSH activities in order to be financially sustainable.

Interview with Yim Viriya

Mr. Yim Viriya is the executive director of Clear Cambodia. This NGO works on a number of significant initiatives related to safe water and sanitation and supervises WaSH programs.

Describe the current water situation in your country in terms of health, access, and scarcity.

The CMDG (Cambodia Millennium Development Goal) targets for providing "access to a safe water source" by 2015 are 50 percent for the rural areas. According to the latest figures available from the CDHS (Cambodia Demographic Health Survey) from 2010, 53 percent of the rural areas have access to improved water supply (dry season), so while the target has been achieved, that leaves 47 percent still without access to safe drinking water. In terms of sanitation, Cambodia still has a high percentage that practices open defecation (56.7 percent, CDHS 2010), and while the practice of using latrines is growing, Cambodia is slightly off-pace from the CMDG target of 30 percent of the rural populations using an improved sanitation facility (24.7 percent, CDHS, 2010).

What are major waterborne diseases in your country and/or region where you operate?

In 2010, Cambodia had some of the highest infant and under-five mortality rates in the region, at 43 and 51 per 1,000 live births, respectively. As well, vaccine-preventable diseases, diarrhea, and respiratory infections are among the leading causes of early childhood death. Internal data compiled from installation visits from target areas from 2011 to 2013 showed that 37 percent of children under the age of five had diarrhea within the previous two weeks.

What are the significant barriers to water quality, health, and access and what is the 10-year and 25-year outlook?
The significant barriers to water quality, health, and access are knowledge on water-related illnesses, less value placed on water quality, negligence on health conditions, shortage of facilities, poor living standards (in the rural areas), and the government did not prioritize the budget for water quality though many policies were made. There are approximately 25 percent of households that have water that meets the WHO and Cambodia standards for *E. coli* (0 cfu/100 ml). Washing hands with soap is also not generally practiced by the rural people.

Describe any groups or minorities that face specific hardships regarding water access and health.
People living around Tonle Sap especially people who are living on floating houses or boats and children under five years of age in the rurala reas.

What is being done at the national or local government level to assist these groups?
Due to the governments' limited resources in working with people who are living on floating houses or boats, in order to provide clean and potable water to these communities, some NGOs provide filtration systems to community committees for them to sell water to these groups. The water used to clean foods and dishes is a critical issue of contamination.

What policies is the national government developing or conducting to expand water/sanitation health and access?
The government policies (national guideline on household water treatment and safe water storage) are: (1) protecting sources of water; (2) household water treatment; (3) safe water storage; (4) education and behavior change for good practices of using water.

What policies would you like to see the national government introduce to improve water/sanitation access, quality, and health?
The policies I would like to see the national government introduce to improve water/sanitation access, quality, and health are HHWS (household water systems), SWS (Safe Water Storage), and sanitation.

Describe particular problems facing vulnerable and minority children with respect to water access and health.
In the rural areas, the majority of parents especially women migrated to the city or outside the country for employment. The caretakers or people who look after young children, specifically under five years of age, are elders and the elderly. Due to their limited knowledge of WaSH, many problems arise for the children such as diarrhea, malnutrition, being underweight, and respiratory problem.

What environmental problems are impacting water quality?
The environmental problems that are impacting water quality are: open defecation, safe water storage, poor practices on hygiene, and the use of chemicals for agriculture.

What are three major steps that could be taken in the future to improve the general water health and access situation?
The three major steps that could be taken in the future to improve the general water health and access to situation are: (1) education and behavior change; (2) a motivated private sector to be involved in water and; (3) effective coordination at all levels of stakeholders.

Describe two or three innovate water development or rights project that are assisting people.
The innovative water development projects that can assist people are: (1) provision of water pipe systems to communities; and (2) provision of big water purification systems like slow sand filters to the village/commune.

How important are the local NGOs and the international NGOs in protecting and advancing water rights and development in your country?
Advocacy and involvement in reviewing policies to consider whether the requirements of vulnerable and marginalized individuals and groups are addressed.

Describe your own background in water-related work and development.
For household water treatment, Clear Cambodia has chosen the BSF (bio sand filter) to help the rural community people to access clean water. Our motto is that "we work with people." It means that, people have to be involved with all processes set by the project until the

products are completed and they are trained on how to use and maintain the facilities. Clear Cambodia is also implementing WaSH projects at schools. The provision of big slow sand filters to schools and WaSH training to teachers as well as school children are provided.

Describe the importance of improved sanitation systems for health and water safety in your country or state/province.
To provide facilities such as water purification systems, latrines, and education on behavior change regarding WaSH is very important to improve sanitation systems for health and water safety in my country.

Describe the major priorities in your own work for the next five years.
In the next five years, Clear Cambodia has three major priorities that are to provide as much as possible: (1) BSFs for households; (2) School WaSH environmental sanitation; and (3) Slow sand filters for health centers.

CHAPTER THREE

India: Drought, Climate Change, and Poverty

Country Overview

India is the second most populous country in the world and is burdened by significant poverty and income inequity. It has 16 percent of the global population and only 4 percent of the global water resources. By 2050, the population is expected to reach 1.6 billion people, surpassing China. Water stress is clearly evident in India and as population surges this situation will be exacerbated to the point of water scarcity in many parts of the country. Inevitably, providing clean, safe water for citizens and water for agriculture will be difficult challenges. There are 400 million citizens living below the international poverty line of (USD 1.25 per day) and a population of 167 million Dalit's who suffer chronic and systematic social and economic discrimination that has endured for centuries. The marginalization of minority groups and vulnerable populations in India is widespread and this reality extends to water health and security. Water scarcity, climate change, drought, flooding, water delivery infrastructure at the rural level, extreme poverty, waterborne diseases, and water pollution are combined challenges that confront the Indian government and people. As a comparative illustration on the accelerating scarcity of water, per capita water availability was 5177 m^3 in 1951 and lowered to 1545 m^3 in 2011. Based on international standards, water stress is indicative when a nation's water availability is less than 1700 m^3 per capita per year. According to projections, by 2050 India is facing water availability levels of 1191 m^3.

Major health, economic, and water indicators
Human Development Index (HDI) for India, 2014: 135.
Population, 2014: 1.252 billion
Gross national income (GNI), 2012: USD 1514.00
Life expectancy, 2012: female: 67.6;
male: 64.4
Improved rural water source, 2012: 91 percent
2010: 88 percent
Population percentage with access to improved sanitation, 2013: 34 percent
global average: 72 percent
Rural population, 2012: 68.4 percent
Poverty index, 1998: 21.9 percent
Homeless population, 2014: 0.974 percent
Carbon dioxide emissions per capita (tons), 2014: 1.67

The government of India has acknowledged the severity of the water security crisis. A recent report by the Ministry of Water Resources noted that, "due to limited availability of water, but growing demand of water due to increasing population, urbanization and industrialization, India is facing water stress. In addition, due to contamination of water sources and poor water treatment facilities it is often difficult to get safe drinking water."[1] An estimated 100,000 people die from waterborne diseases annually and over 30 percent of groundwater in India's 600 districts is not safe as drinking water. Moreover, according to the World Health Organization (WHO), approximately 780,000 deaths in India annually are caused by unsafe drinking water and inadequate sanitation. It is clearly established in the health medical literature that unsafe, contaminated water causes up to 90 percent of diarrhea cases. The United Nations has reported that India ranks hundred and twentieth among 122 nations in terms of the quality of water available to citizens. The Indian Central Pollution Control Board has analyzed water quality in rural India and reports that 1.42 million villages in India are affected by the chemical contamination of water. As demographic and migration patterns in the country shift from slower rural population growth to accelerated urban growth, the strains on the urban water resources and increasing pollution will be evident. In 2005, India utilized about 829 billion cubic meters of water per year for the domestic, agricultural, and industrial sectors. By 2050, the projections are for 1.4 trillion cubic meters of supply. "Sectoral demands for water are growing rapidly in line with urbanization and estimates suggest that by 2025, more than 50 per cent of the country's population will live

in cities and towns, population increases, rising incomes and industrial growth, and urban India is fast emerging as centers of demand growth. As a result, per capita water availability has been falling."[2]

The relationship between poverty and water deprivation is strong. According to the Indian Planning Commission, "close to 40 percent of its 1.15 billion population is poor being mostly small and marginal farmers, belonging to socially backward communities, and poverty data suggests that they are getting concentrated in traditionally poor areas such as the states of Orissa, Madhya Pradesh, and Bihar.[3] The regional concentration of poverty and deprivation is reinforced in the new measurements carried out using the MPI (multidimensional poverty index).[4] By including deprivation of access to water and sanitation as two of the ten indicators in the index, the MPI not only increases the incidence of poverty (to 55 percent of the Indian population), but also shows regional concentration of poverty in India: the eight states of Bihar, Chattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, and West Bengal are home to 421 million poor people, more than the numbers in the 26 poorest African countries combined (410 million).[5]

New Delhi: City Water Profile

New Delhi is the capital of India and the fifth most populated city in the world. It is situated in Northern India on the right bank of the Yamuna River and shares borders with the neighboring states of Uttar Pradesh and Haryana. From 400,000 people in 1901, population surged to 13,782,976 in 2001, 16,753,235 in 2011 and 17.8 million in 2014. The Yamuna River is Delhi's primary source of drinking water. The heavily polluted river originates at the Yamnotri glacier in the lower Himalayas at an elevation of about 6387 meters above sea level and flows for 1376 kilometers to its end point at Allahabad. There are five major pollution issues affecting water quality in the Yamuna River. "First, the Yamuna's 22-km stretch in Delhi is barely 2 per cent of the length of the river yet contributes over 70 per cent of the pollution load; second, Delhi discharges about 3,684 MLD (million liters per day) of sewage through its 18 drains into the Yamuna and along with Agra it account for 90 percent of the pollution in the river; third, at downstream Okhla, the DO (dissolved oxygen) level declined to 1.3 mg/l with the BOD (biochemical oxygen demand) at 16 mg/l, indicating considerable deterioration in water quality due to discharge of sewage and industrial effluents; fourth, from big industries and factories

to people living in big colonies, slums and the rural areas in Delhi, all pollute the river with impunity because of untreated water and fifth, the Delhi Jal board said that the river remained a sewage canal due to the 143 unauthorized colonies, 1080 slums and villages that present a problem in collection of sewage water that flows into the Yamuna untreated."[6] Moreover, the Indian CPCB (Central Pollution Control Board) has designated the Yamuna River water quality at category "E" which indicates it is unfit for human consumption. Delhi faces the dual challenges of rapid population growth and severe water pollution levels which pose difficulties for sustaining water security. According to one study, "water quality in the Yamuna River in Delhi was very poor both in February and June. DO levels approached zero, and TDS levels were five times greater than levels seen in the Upper Ganges (i.e., 504 mg/L vs ≤107 mg/L; Table 1). The Yamuna receives massive inputs of agricultural, industrial, and domestic pollutants with some reaches along the river having a septic odor. This suggests anoxic conditions prevail near the water surface, which is unusual for such a large river that typically would have greater dilution, better mixing and more reaeration during normal flow conditions."[7]

The average annual rainfall in Delhi is approximately 714 mm of which 75 percent falls in the July–September period. This short-term annual deluge of water also creates flooding problems which shows evidence of acceleration from global warming. Delhi is also facing a growing gap between water supply and water availability for city residents. "In Delhi, 3,156 million liters of water (MLD) is supplied against the requirement of 4,158. But around 40% of the supply is lost in distribution resulting in a much wider gap between demand and supply than what's recorded."[8] In general, piped water is available to city residents for about 4 hours per day and the water has been found to contain carcinogenic substances.

An additional health burden facing the city is the low level of waste treatment and chronic practice of depositing sewage into the Yamuna River. Delhi deposits up to 58 percent of its sewage directly into the Yamuna River. With the urban population swelling, pollution levels are increasing. "Delhi is producing 1,900 million liters per day (MLD) of sewage but Delhi Jal Board (DJB) responsible for managing sewage is collecting and treating only 54 per cent of the total sewage generated in the city. Moreover the Comptroller and Auditor General of India has found out that 15 out of 32 sewage treatment plants are working below their capacities."[9] As noted by the Government of India Central Pollution Control Board, "the lack of wastewater treatment capacity in

cities like Delhi and Kolkata threatens public health and the safety of already-scarce freshwater resources. A discussion on water security is incomplete without planning for adequate infrastructure for wastewater treatment."[10]

Health and Human Rights Challenges

In 1961, US President John F. Kennedy observed that "if we could ever competitively, at a cheap rate, get freshwater from salt water that would be in the long-range interest of humanity and would really dwarf any other scientific accomplishment." In India, the challenge of securing clean drinking water is a fundamental health, human rights, environmental, and economic imperative for the country. Approximately 37.7 million Indians are affected by waterborne diseases annually; diarrhea continues to effect the highest number of people among waterborne diseases, 66 million Indians are at risk due to excess fluoride and 10 million due to excess arsenic in groundwater.[11]

India is affected by a myriad of water pollution issues including the chemical contamination of water, high fluoride and arsenic levels in drinking water that may have contaminated up to 100 million people, high levels of industrial toxins in drinking water sources, and dangerous bacterial levels in drinking water sources from untreated sewage. "A major cause of child mortality in India, currently at 79 per 1000 children, is a result of limited access to safe WaSH (Water and Sanitation Hygiene). Children may survive, but may continue to suffer from chronic diarrhea, resulting into poor absorption of nutrients; 43% of Indian children aged less than 5 years are malnourished, and 48% are stunted and 70% of children are anemic."[12] High rates of poverty and water pollution exact a heavy burden upon the population. Moreover, a correlation can be drawn between poverty and water insecurity in the critical areas of health and access. Although waterborne diseases are evident in all regions of the country, a disproportionate number is found in rural India. The risk of major infectious diseases in India is very high. "Food or waterborne diseases include bacterial diarrhea, hepatitis A and E, and typhoid fever, vector borne diseases include dengue fever, Japanese encephalitis and malaria. Leptospirosis is a water contact disease."[13] The most common waterborne diseases in India include: cholera, diarrhea, malaria, and typhoid. Cholera, is caused by the bacteria *Vibrio cholerae.* Diarrhea is caused by a host of bacterial, viral, and parasitic organisms that are often spread by contaminated water.

Chronic diarrhea can be particularly threatening due to the weakening of the body and immune system. Sources of infection include parasites such as *Cryptosporidium, Cyclospora, Entamoeba histolytica, Giardia,* microsporidia; bacteria such as Aeromonas, *Campylobacter, Clostridium difficile, E. coli, Plesiomonas, Salmonella, Shigella*) and viruses such as the norovirus and rotavirus. Malaria is a mosquito-borne disease caused by a parasite. Typhoid fever is caused by the bacterium *Salmonella enterica* serotype Typhi. Paratyphoid fever is similar and is caused by *Salmonella enterica* serotype Paratyphi A, B (tartrate negative), or C.

Diarrhea is a chronic problem in India and one that is clearly exacerbated by contaminated water and unsafe sanitation systems. Chronic diarrhea is a specific health threat to young children because of the underdevelopment of their physical and immune system. It was estimated that in 2005, 302,000 children age 1–59 months died due to diarrheal diseases giving a mortality rate of 11.1 per 1000 live births.[14] The WHO and UNICEF have proposed a seven-point action plan to reduce childhood diarrheal morbidity and mortality rates. Features of the plan include: (i) fluid replacement to prevent dehydration, (ii) zinc treatment, (iii) rotavirus and measles vaccinations, (iv) promotion of early and exclusive breastfeeding and vitamin A supplementation, (v) promotion of hand washing with soap, (vi) improved water supply quantity and quality, including treatment and safe storage of household water, and (vii) community-wide sanitation promotion.[15] Improving sanitation, ensuring a supply of safe drinking water, promoting good hygiene and hand washing are likely to have substantial gains not just for childhood diarrheal diseases but also for reducing the burden of enteric diseases in all age groups; the disease burden in older children and adults in India is also substantial.[16] An estimated 400,000 deaths annually are linked to water contamination. On a positive note, guinea worm was certified in 2007 by the WHO as eradicated in India. The Centers for Disease Control and Prevention, WHO, UNICEF, and humanitarian work of President Carter and the Carter Center's Global 2000 have contributed to this remarkable health milestone for India.

One of the great challenges facing India is water security in the face of chronic pollution, water scarcity, climate change, and poverty. As population levels in India inevitably surge, these challenges in many instances will be exacerbated. India's population base of 1.2 billion (2015) which includes 400 million citizens living in extreme poverty, poses serious development burdens upon the nation and policymakers. By 2050, India is projected to have a population of 1.6 billion. Currently, the rural population is 857 million or 71 percent of national

population. The rural population is expected to decline to about 800 million by 2050 yet conversely, the urban population, currently at 384 million (2015) or 32 percent of the population is expected dramatically increase to 50 percent of national population at 800 million. Population demographics reveal a steady upward trend in the urban population. In 2014, the major cities of Delhi, Mumbai, and Kolkata (Calcutta) have populations of 17. 8 million, 20 million, and 14.7 million respectively. By 2030, population projections for these megacities are: 36 million for Delhi; 27.7 million for Mumbai, and 19 million for Kolkata.

According to WHO–UNICEF data, as of 2008, about 96 percent of the urban population and 84 percent of the rural population had access to improved water sources.[17] Average access to drinking water is highest in Class 1 towns (73 percent), followed by Class 2 towns (63 percent), Class 3 towns (61 percent), and other towns (58 percent).[18] In India, cities and towns are routinely categorized in classes for population data purposes. Class 1 denotes a population of 100,000 or higher; class 2 is 50,000–99,999; class 3 is 20,000–49,999; class 4 is 10,000–19,999 and class 5 is 5,000–9,999 inhabitants.

India: Environmental Refugees

India has been beset by innumerable climate problems since recorded history. Yet a relatively new environmental phenomenon is emerging, climate change, which is demonstrating increasingly adverse effects upon the population and economy. According to the 2012 Global Governance Project, climate refugees are defined as a grouping of environmental migrants forced to move "due to sudden or gradual alterations in the natural environment related to at least one of three impacts of climate change: sea-level rise, extreme weather events, and drought and water scarcity."[19] Indeed, as early as 1990, the United Nation's Intergovernmental Panel on Climate Change sounded an alarm bell over this looming global crisis. The report noted ominously that the greatest single consequence of climate change could be migration, "with millions of people displaced by shoreline erosion, coastal flooding and severe drought."[20] Many analysts predict that due to India's emerging water shortages, millions of citizens will in effect become "water refugees." In this future scenario, the enemies will be scarcity, pollution, drought, and famine. It is already well documented that in Northern India water sources are depleting faster than nature can replenish them. According to a World Bank report, the future of India's groundwater is critical.

"If current trends continue, in 20 years about 60 percent of all India's aquifers will be in a critical condition. India is the largest user of groundwater in the world. It uses an estimated 230 cubic kilometers of groundwater per year—over a quarter of the global total. More than 60 percent of irrigated agriculture and 85 percent of drinking water supplies are dependent on groundwater. This will have serious implications for the sustainability of agriculture, long-term food security, livelihoods, and economic growth. It is estimated that over a quarter of the country's harvest will be at risk. There is an urgent need to change the status quo."[21]

Predictable and scientifically plausible outcomes of climate change for India include migration in the millions, flooding of lowland areas, increased flooding in flood prone regions, rising sea levels, saltwater intrusion which will damage agricultural lands and economic security, lowered food production, water scarcity, regional drought, and medical crises. In a nation with a history of devastating drought and flooding, the acceleration of these natural events will be a further human development burden. India has 7,500 kilometers of coastline spanning nine states which will be affected to varying degrees and susceptible to flooding, sea level elevation, saltwater intrusion, agricultural and other economic losses. According to some estimates, as many as 120 million people in India and Bangladesh could be environmental refugees by the year 2100.[22] Another study predicts that nearly 32 percent of India's coastal area will be vulnerable to inundation due to sea level elevation with an additional 8,693 square kilometers of land area, 3,744 square kilometers of agricultural land, and 7,640,416 citizens at risk from storm surge and sea level elevation with major cities such as Bhavnagar, Jamnagar, Surat, Thane, and Vadodara threatened by the risk of intensification from storm surges.[23] The mega cities of Mumbai and Kolkata are threatened by rising sea level elevations and storm surges which will inevitably trigger a potential exodus of thousands of citizens who migrate away from vulnerable coastal areas. An analysis on the impact of climate change upon sea level elevations noted that, "a 1 meter sea-level rise can put 145 million people at risk, 41% of whom will be in South Asia, and 32% in East Asia."[24]

Water Security and Agriculture

In 2011, there were 118.9 million people engaged in agriculture or 24.6 percent of the total workforce of over 481 million. India is among the top growers of agricultural produce in the world and therefore the

consumption of water for irrigation is among the highest at 91 percent compared to 70 percent in most countries. Water stress in the agricultural sector will compound existing water security issues in rural regions. About 30 percent of the rural households have piped water sources and 50 percent of this water is untreated. The 2011 census estimates that 138 million rural households, or about 685–690 million people, lack access to safe drinking water.[25] Agriculture is paramount to India's economic and employment sustainability yet water security and irrigation sources are continuously under threat. Presently, about 80 percent of irrigation water is sourced from groundwater. However water availability is in serious decline as noted, from 1951 per capita water availability of 5177 m^3 to 1545 m^3 in 2011.

During 2008–2009, the production of food grains was estimated at 233 million tons, including 99.15 and 80.58 million tons of rice and wheat, respectively. It is estimated that by 2020, food grains requirement will be almost 30–50 percent more than the demand in 2000. Indian agriculture is facing challenges from several factors such as increased competition for land, water, and labor from nonagricultural sectors and increasing climatic variability. Agricultural production is sensitive to variations in climate conditions even at minimal level. Thus significant climate changes, as predicted by leading experts and IPCC reports, are expected to bear heavily upon the food security scenario in India.

Agriculture contributes approximately 18 percent to India's GNP. "The rice-wheat system in the Indo-Gangetic Plain, which meets the staple food requirements of more than 400 million people, is a highly vulnerable regional system. The system, which covers an area of around 13.5 million hectares in Pakistan, India, Bangladesh, and Nepal, provides highly productive land and contributes substantially to the region's food production. Declining soil productivity, groundwater depletion, and declining water availability, as well as increased pest incidence and salinity, already threaten sustainability and food security in the region."[26] Clearly, food security is a national priority for India. The consequences of water scarcity, declining food production, increased unemployment in agriculture, flooding, and salt water intrusion in cultivated lands are severe for India.

Case Study: The Human Right to Water

Access to drinking water is often dependent upon income and caste issues and power relations within the community. Moreover, there

are well-documented cases of the Dalit minority group regularly being denied access to drinking water sources such as wells and being assaulted or even killed when trying to do so. In India, several significant judicial rulings have affirmed water rights. In Subhash Kumar versus State of Bihar (1991), the Supreme Court of India held that the right to live "includes the right of enjoyment of pollution-free water and air for full enjoyment of life. If anything endangers or impairs that quality of life in derogation of laws, a citizen has right to have recourse to Article 32 of the Constitution for removing the pollution of water or air which may be detrimental to the quality of life."[27] In *M. C. Mehta vs Kamalnath* (1997) the Supreme Court ruled that the state is not only bound to regulate water supply but should also support the realization of the right to healthy water and prevent health hazards. In the Indian Constitution, providing every citizen with adequate clean drinking water and protecting water from pollution is a basic Directive Principle in the nation's governance as well as a right under Article 21 of the Constitution.

Despite legal and constitutional safeguards to water there are large segments of the population who encounter systematic and severe discrimination related to water access and rights. The tragic denial of rights falls particularly hard on the Dalit community. The word "Dalit" comes from the Sanskrit root "dal" which means broken, or oppressed. The Hindu caste system in India, dating before the time of Buddha, represents a rigid social structure of hierarchal power and social standing within society. There are four main groupings within the overall caste system. In order of social standing these include the Brahmins (priests and teachers); the Ksyatriyas (rulers and soldiers); the Vaisyas (merchants and traders); and the Shudras (laborers and artisans). A fifth category, which falls outside the traditional caste system, is known as the untouchables or Dalits who are considered unclean and impure. They perform the lowest forms of work in Indian society. The Indian Constitution Act of 1949 addressed the issue of oppression against the Untouchables. According to Article 17 of the Act: "Untouchability is abolished and its practice in any form is forbidden. The enforcement of any disability arising out of untouchability shall be an offence punishable in accordance with law."[28] In 2015, the Dalit population numbered approximately 167 million. A study conducted in 2006 found that in India more than 20 percent of Dalits did not have access to safe drinking water and 48.4 percent of Dalit villages were denied access to a water source.[29]

In 2013, the NHRC (National Human Rights Commission) requested a formal report from the Bihar government over the denial of water to Dalits by upper-caste people in Kishanganj. In a submission to the Commission, a Dalit human rights NGO noted, "Some of the violations, which Dalits face in India, are the following: exclusion in access to basic services and extreme poverty, exclusion, segregation, and discrimination against Dalits in the education and health sector remain a widespread problem in India (e.g., access to adequate housing, water and sanitation, and land). Out of India's 37.2 % poor population (323 million people), the majority of them are Dalits (47.2% in rural areas and 39.9% in urban centers)."[30] Discrimination and violence against Dalits in the area of water security has been a prolonged and severe human rights issue in India for centuries. Despite 1947 constitutional guarantees against discrimination and the 1989 Atrocities Act designed to curtail and punish abuses against the marginalized and aggrieved minority, progress remains slow. Recent data underscores the realities of water deprivation. "About 27% of Dalit households have water sources within premises whereas for others it stands at 45.2 percentage; 19.5 % of Dalit households have access to drinking water sources away from their premises whereas it stands at 14.4 % for others; 32.2 % of Dalit households have access to drinking water from a tap, whereas for others it stands at 40.1 %."[31]

Environmental Challenges

Pollution is an ongoing and severe problem in India which has a detrimental effect on air and water quality and the health of millions of citizens. One of the common complaints against authorities at the state and national level is that effective systems are not in place to monitor pollution. Moreover infrastructure investment in systems such as sanitation, water piping, and sewage treatment are lower than required. There are also complaints that government oversight is lacking in some areas which can lead to inadequate measures and even corruption. For example the government Jal Board, Delhi Jal Board Act (1998), was established to oversee water supply, sewerage, and sewage disposal and drainage within the National Capital Territory of Delhi. In 2005, a government audit revealed that the Jal Board spent USD 200 million on pollution cleanup activities yet no evident improvements were seen. It is estimated that New Delhi produces 3.6 million cubic meters of

sewage every day though only 50 percent is treated. The remainder flows into the Yamuna River which is the main water supply for the city.

Rivers in India generally contain high fluoride content that exceed the permissible level of 1.5ppm and this affects upward of 70 million citizens. According to the Indian Government Planning Commission, "water pollution is adding to India's water woes with almost 70 per cent of surface water and an increasing percentage of groundwater being contaminated by biological as well as chemical, organic, inorganic and toxic pollutants. The sources of such pollution include point sources such as industrial effluents and domestic waste, and non-point sources such as agriculture. The health implications of poor water quality are enormous, and water and sanitation related diseases are responsible for 60 per cent of the environmental health burden in India."[32] Sanitation standards and systems in many regions are unsafe and contributors to the country's disease burden and water-health insecurity. Another serious health and development problem is the practice of open defecation which accelerates the contamination of soil and water sources and contributes to the overall disease burden of the country. According to data from the Ministry of Rural Development, "approximately 638 million people in India still defecate in the open and 67 per cent of households do not have treated drinking water. Likewise, in the urban areas water supply pipelines and open drainage channels running side by side jeopardize the safety of drinking water. Surveys have estimated that over one third of rural ground water sources in India may be microbiologically contaminated, much of this contamination is preventable and proper operation and maintenance of water sources coupled with safe sanitation practices."[33]

Climate Change

Climate change is an area of tremendous concern to the Indian government due to its devastating effects upon the population. The adverse effects of climate change have been well documented by the scientific community and the governments' own research studies. The Climate Change Vulnerability Index ranks the vulnerability of various countries to extreme climate change–related events. India has the second worst assessment ranking after Bangladesh. The Indian Government's NATCOM (National Communications) 2004 report enumerated the

following repercussions of climate change that are anticipated to impact India by the year 2100.

> Decreased snow cover will affect snow-fed and glacial systems such as the Ganges and Brahmaputra. 70% of the summer flow of the Ganges comes from melted water. Erratic monsoons will affect India's rain fed agriculture, peninsular rivers, water and power supply, wheat production will drop by 4–5 million tons, even with a rise in temperature of only 1 C. Rising sea levels will cause displacement along one of the most densely populated coastlines in the world, also threatening freshwater sources and mangrove ecosystems. Floods will increase in frequency and intensity. This will heighten the vulnerability of people in the country's coastal, arid and semi-arid zones. Over 50% of India's forests are likely to experience a shift in forest types, adversely impacting associated biodiversity, regional climate dynamics and livelihoods based on forest products.[34]

India is also threatened by the encroaching glacier melting in Tibet. The Tibetan Plateau, referred to as the "Third Pole," is the sustaining water source for important Indian and Asian rivers. Global warming and glacier melting has already been widely studied in this crucial water source and poses a significant threat to water security and economic livelihood for up to 2 billion people. The Tibetan Plateau holds approximately 45,000 glaciers covering an area of 105,000 square kilometers and comprises an area of about 2.5 million square kilometers. With an elevation of 4,500 meters above sea level, the Tibetan Plateau spans 3,000 kilometers from west to east and 1,500 kilometers from south to north. It is a crucial water source that feeds several important rivers including the Brahmaputra, Ganges, Indus River, Mekong, Yangtze, and Yellow. A study by NASA revealed that 20 percent of the Tibetan Plateau glaciers have retreated in the past 40 years and if the current trends continue, more than 60 percent of the existing glaciers could disappear over the next four decades.[35]

The NWM (National Water Mission), a sector of the NAPCC (National Action Plan on Climate Change) has also identified specific threats to Indian water resources caused by climate change. These include: an expected decline in the glaciers and snowfields of the Himalayas; increased drought-like situations due to the overall decrease in the number of rainy days over a major part of the country;

increased flood events due to the overall increase in the rainy day intensity; effect on groundwater quality in alluvial aquifers due to increased flood and drought events; impact on groundwater recharge due to changes in precipitation and evapotranspiration; and increased saline intrusion of coastal and island aquifers due to rising sea levels.[36] Conditions of drought and flooding are common weather events that have affected India for centuries. Most scientists expect these patterns to be exacerbated due to climate change. In recent years drought conditions have been particularly difficult in Beed, Nanded, Parbhani, Jalna, Aurangabad, Nashik, and Satara in the State of Maharashtra. About 12 percent of the country is flood prone and 20 percent is drought prone. In 2009 alone, 14 states declared drought-like emergencies in a total of 338 districts in regions as diverse as Himachal Pradesh, Assam, Jharkhand, Manipur, and Nagaland. Lowering water tables and historic challenges with water storage will add to the challenges of water security. According to a recent ADB report, "the sub region has a low resilience due to low per capita water storage capacity. As a result, South Asia is likely to be particularly vulnerable to the effects of climate variability, including increased frequency and severity of drought or flood events. Large irrigation systems are widely considered to be underperforming in terms of water services provided to farmers and the sustainability of infrastructure, with inadequate investment in maintenance."[37]

In a survey of the ten worst drought disasters globally over the past 100 years, six occurred in India. "The cumulative damage affected up to 300 million people. The droughts of 1987 and 2002–2003 affected more than 50 percent of the crop area in the country. Devastating droughts in the states of Jharkhand, Orissa, and Chhattisgarh, which occur approximately every five years, are estimated to affect around 40 percent of rice production, an $800 million loss in value."[38] Coastal flooding, salt water intrusion, and elevated health crises due to flooding are all symptomatic of climate-change patterns that will affect India. The coastal cities of Mumbai and Kolkata (Calcutta) have heightened vulnerability to flooding. Moreover, both cities have large slum populations who are particularly affected by the devastation of flooding, disease, home destruction, and economic loss. Mumbai has a population of 20.5 million (2012) and 41.3 percent of the urban dwellers live in slums according to the 2011 Indian Census. About 30 percent of Kolkata's population of 16 million are slum dwellers. Kolkata city and the surrounding metropolitan area rest a mere 1.5 to 11 meters above sea level. A report by the Indian Ministry of Environment and Forests

noted that "all the regions show an increase in the flooding varying between 10 to 30% of the existing magnitudes. This has a very severe implication for the existing infrastructures such as dams, bridges, roads, etc., for the areas, and shall require appropriate adaptation measures to be taken up."[39]

The adverse effects of climate change upon health are noticeable in two profound areas. Diarrhea is a major waterborne disease and contributor to both catastrophic illness and fatality particularly among young children. Approximately 13 percent of child deaths in Asia are caused by diarrhea. Health is a critical area where climate change will have a noticeable and negative impact. Pandey investigated the impact of climate change on the incidence of diarrheal disease in South Asia and found "a declining trend in the incidence of the disease but an increase of 6 percent by 2030 (and an increase of 1.4 percent by 2050) in the relative risk of disease from the baseline, compared to an average increase across the world of 3 percent in 2030 (and 2 percent in 2050). A notable finding in his research was that in the absence of climate change, cases of diarrheal disease in South Asia would decrease earlier, as the expected increase in income would allow South Asian countries to invest in their health services."[40]

The expected sea level rise will inevitably effect health due to a number of factors. These include flooding, drowning, diseases caused by flooding, increases in malaria due to rising temperatures that attract an increase in the mosquito population, food shortages and malnutrition, population displacement and forced migration, illness associated with heat waves, and a rise in stunted growth which is predicted to occur. The relative risk of malaria in South Asia is projected to increase by 5 percent in 2030 (174,000 additional incidents) and 4.3 percent in 2050 (116,000 additional incidents) in the wetter scenario.[41]

The Ganges River

The Ganges River, which is a sacred waterway, extends 2,525 kilometers with a watershed covering more than one million square kilometers representing about 25 percent of India's total area. It flows through India, Nepal, Bangladesh, and China. The Ganges has several large tributaries including the Kali, Ramganga, Yamuna, Gomti, Ghaghara, Gandak, and Kosi. The Yamuna River is a tributary of the Ganges and supplies water to Delhi. Approximately 43 percent of the population or 500 million people across 11 states use the waters of the Ganges River. The Ganges is ranked as one of the five most polluted rivers in India

with extreme levels of pollution in many sections. It is estimated that 3 billion liters of sewage is deposited into the Ganges daily and only 30 percent of this toxic pollution is treated. The level of BOD for the Ganges is a health and environmental concern. A Biochemical Oxygen Demand of 3 mg/l or less in water indicates freedom from oxygen demanding pollutants and less production of obnoxious gases. Good water quality should not have a BOD level higher than 3mg/l. In many sections of the Ganges this safety level is dangerously exceeded. There is evidence that sections of the Ganges near the city of Haridwar have BOD levels at 5.5 mg/l which were analyzed in 2008.

The high pollution level of the Ganges has been created by the mass scale and chronic deposit of sewage and toxic chemicals into the waterway. It is perplexing that a river so revered in Indian culture has been so badly polluted. According to a recent Government report on the environmental condition of the river by the CPCB (Central Pollution Control Board), "the Ganges has fifty cities located along the more than 2,500-km River that discharge 2,723.3 MLD (million liters a day) of wastewater into it. The situation is further complicated by 138 drains that discharge thousands of liters of wastewater into the Ganga and the critical condition of two of its tributaries, Ramganga and Kali. The monitoring results obtained during 2011 under the National Water Quality Monitoring Programme reflect that organic matter and bacterial population of fecal origin continue to dominate the pollution problem in River Ganga."[42] The problematic issue of rampant pollution that endangers the health of hundreds of thousands of citizens who depend upon the waters of the Ganga River is symptomatic in part of the weak enforcement and inspection regime for environmental protection in the country. Moreover, the problem is also a function of poverty since the cost of effective sanitation systems is not a government or community priority in many regions thus leading to the unhygienic practice of open defecation. In the Ganga River, "BOD ranges from 0.2–11.0 mg/l. The highest value 11.0 mg/l is observed at D/s Haridwar. Fecal coliform value ranges from 5–46000 MPN/100ml and not meeting the water quality criteria for bathing in river Alaknanada at Rudraprayag before confluence (B/c) & after confluence (A/c) river Mandakini and at Devraprayag B/c & A/c River Bhagirathi. While the total Coliform value ranges 5–580000 and not meeting the primary water criteria based on designated best use for category 'C' at all monitored locations of river Alaknanda and Mandakini; and in river Ganga at D/s Raiwala and D/s Haridwar. The higher value of coliform bacteria and organic pollution is observed in Upper Ganga due to open defecation and

discharge of waste water directly through small drains into the river."[43] In 2014, the Minister of State for Water Resources informed the House that a total of 1649 gram panchayats in five states have become part of an action plan to make the banks along river Ganga free of open defecation. Panchayats are village development cooperatives that are common throughout India. The government goal is to have the Ganga River free of this practice by the year 2022.

The stretch of the Ganges in West Bengal is also heavily polluted. In this stretch of the river it is known as the Hoogly River. Here, the river "receives 87 MLD wastewater from 22 grossly polluting industries. It is observed that the chemical industry discharges 70% of total wastewater generated, followed by pulp and paper which is 20%."[44] "Overall, there are 764 grossly polluting industries discharging wastewater to the main stem of the Ganges River (either directly or through drains) and its two important tributaries Kali-east and Ramganga. Of the total number of 764 industries, 687 are located in Uttar Pradesh."[45] Research and testing undertaken by the Swatcha Ganga (Ganges) Research Laboratory noted considerable levels of pollution dangerous to both health and the environment. The laboratory, based in Varanasi, "which conducts regular water quality tests, found that fecal coliform counts (FCC) range between 16,000 to 60,000 mpn per 100 mL of water from the bathing ghats, which far exceeds the permissible limit (limit for bathing is 500 mpn per 100 mL as stipulated by the CPCB). Similarly, biological oxygen demand (BOD) values are much higher (4.4 to 7.6 mg/L) than the water quality standard of less than 3 mg/L for bathing, particularly between Kannauj and Varanasi."[46] In some stretches of the river, the government has recorded BOD levels of 30 mg/l.

In 2009, the Indian government publicly committed to a sustainable and ecologically sound new direction for the Ganges River. The GAP (Ganga Action Plan) is an ambitious program with several main elements. It is to be conducted under the auspices of the NGRBA (National Ganga River Basin Authority). Among the new measures taken by the Central Pollution Control Board is the inspection of 441 industries as on June 2013 to monitor compliance with standards set by the State Pollution Control Board and to check the adequacy of industries in terms of wastewater pollution. It will also support investments in pollution control, sewage treatment, and waste management. The government is also committed to a 2020 target date for the cessation of all untreated wastewater into the river. These are necessary environmental steps that will depend upon strict oversight and enforcement to ensure effectiveness.

Government Water Policy and Laws

In general, water laws in India are state based. Under the Government of India Act, 1935, states have the authority to legislate in areas of water law and control. States have the power and legal jurisdiction to regulate water supplies, irrigation and canals, drainage and embankments, water storage, hydropower, and fisheries. Over 90 percent of the laws enacted for the utilization of water resources are state level legislation. Water policy, conservation, transborder issues, water scarcity, and global warming strategies are core policy imperatives that the national government is confronted with particularly in light of the threats from climate change. Under Section 17(1)(a) of the Water Act, the function of the State Board shall be to plan a comprehensive program for the prevention, control, and abatement of pollution of streams and wells in the state and secure the execution thereof.

It is incumbent upon the national government as part of national law and constitutional authority along with state government, municipal and panchayat authorities, to protect and improve water resources.

Major Water Policies and Laws at the National and State Level

The Accelerated Rural Water Supply Programme (ARWSP), 1972–1973.
The Technology Mission on Drinking Water, 1986.
The Andhra Pradesh Farmers' Management of Irrigation Systems Act, 1997.
The Department of Drinking Water Supply (DDWS), 1999 established under the Ministry of Rural Development (MoRD).
Madhya Pradesh Sinchai Prabandhan Me Krishkon Ki Bhagidari Adhiniyam, 1999.
The Tamil Nadu Farmers' Management of Irrigation System Act, 2000.
Orissa Pani Panchayat Act, 2002.
Karnataka Irrigation Amendment Act, 2003.
Kerala Irrigation and Water Conservation Act, 2003.
Maharashtra Management of Irrigation System by Farmers Act 2005.
The Chhattisgarh Sinchai Prabandhan Me Krishkon Ki Bhagidari Adhinyam, 2006.
On June 30, 2008, Prime Minister Manmohan Singh released India's first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation

and adaptation. The plan identifies eight core "national missions" to be followed through to 2017. The NAPCC plans to promote the development and use of solar energy for power generation and other uses with the goal of making solar competitive with fossil-based energy options.
The Uttar Pradesh Participatory Irrigation Management Act, 2009.
National Mission on Sustainable Habitat: To promote energy efficiency as a core component of the urban planning, the plan calls for:

- Extending the existing Energy Conservation Building Code;
- A greater emphasis on the urban waste management and recycling, including power production from waste;
- Strengthening the enforcement of automotive fuel economy standards and using pricing measures to encourage the purchase of efficient vehicles; and
- Incentives for the use of public transportation.

National Water Mission: With water scarcity projected to become more severe due to climate change, the plan sets a goal of a 20 percent improvement in water use efficiency through pricing and other measures.

National Mission for Sustaining the Himalayan Ecosystem: The goal is to conserve biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers are melting at an alarming rate.

National Mission for a "Green India": Goals include the afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23 percent to 33 percent of India's territory.

National Mission for Sustainable Agriculture: The goal is to support climate adaptation in agriculture through the development of climate-resilient crops and the expansion of weather protection regimes.

National Mission on Strategic Knowledge for Climate Change is designed to gain a better understanding of climate science and challenges. A major goal is to foster and fund a new Climate Science Research Fund.

Rural Water Supply-Swajaldhara and National Rural Drinking Water Programme, 2010.

New State Laws creating WUAs (Water User Associations) over the past 20 years signify increased state and community involvement in water sustainability issues. Today, 15 Indian states have drafted legislation to allow for the formation of WUAs. The remaining states are in the process establishing the framework for WUAs. Approximately

57,000 WUAs covering an area of 13.5 million hectares across 24 states of India have been established in the country to date. The main purpose of WUAs is to foster improved irrigation water management. The engagement and direct participation of farmers in water management and irrigation priorities through the WUAs is a positive step forward.

Innovative Water Rights Projects

The Relocation of a Washing Community in Bhopal City to Reduce Urban Lake Pollution (#245)

India is beset by significant pollution of freshwater sources utilized for drinking water and general use such as bathing and washing. There is compelling data on the wide extent of waterborne disease and fatalities associated with contaminated water in India. It is estimated that there are 40 million waterborne disease infections annually in India, 1.5 million child fatalities from diarrhea, and 73 million lost work days. The economic burden of these health crises upon India, a developing nation with 400 million people living below the international poverty line of USD 1.25 per day, is estimated at a staggering USD 700 million. With a growing population and increasing water contamination and shortages, there is cause to focus on projects that facilitate healthy water practices and cleaner water sources. One such initiative is the Bhoj Wetland Project in the lower lake of Bhopal City. Water in the lower lake has been assessed and found to contain high levels of chemical and toxic contamination rendering the water unusable for human drinking. Samples were studied by Atomic Absorption Spectrophotometry from above ten sampling stations. Contamination of the lake includes the following elements:

- Manganese is fatal to humans in high concentrations and can cause among other serious symptoms neurological disorders.
- Chromium components are documented carcinogens. It is also known to cause skin irritations and liver damage. It is a toxic substance which becomes subsumed into plants and thus the food chain. Moreover, chromium in plants makes the plants material unhealthy for human consumption and animal feed.
- Copper is a substance that is seldom observed in natural water. It has negative effects upon aquatic life including fish stocks.

- Lead is a major contaminant in water. Industrial waste, electroplating wastes, corrosion products, and waste contamination contribute lead to water supplies. Approximately 60 percent of lead in the human body enters the bones and affects metabolic function. Lead reaches water bodies from air and rocks. It enters the food chain. Lead poisoning has been linked to kidney damage, mental impairment, abnormal pregnancy, gastrointestinal stress, fatigue, impaired muscular function, and CNS syndrome which has multiple symptoms including convulsions, coma, and finally death.
- Zinc is documented to cause renal damage. The zinc tolerance limit in drinking water is 5.0ppm.
- Cadmium contamination from industrial chemicals and wastes are known to cause liver and kidney damage. Cadmium is toxic to living organisms in levels as low as <1 mg/L.

Bhopal is located in the State of Madhya Pradesh and became the capital city in 1956. The city has experienced rapid population growth to its current level of 1.6 million people in 2015. The accelerated surge in population has been accompanied by extensive economic and industrial growth. One of the serious consequences of this growth has been the accelerated rise in contamination of natural water sources, most significantly the Upper and Lower Bhopal Lakes. The dramatic extent of environmental contamination and health hazards persuaded the state government of Madhya Pradesh to implement the Lake Bhopal Conservation and Management Project, known as the Bhoj Wetland Project, in 1995.

The Lower Lake was not used as a source of potable water but served to supply raw water for surrounding urban development. The Lower Lake receives water inflow from the Upper Lake and from 28 drains that flow into it. According to one report, "Being situated in the heart of the city in a bowl shaped catchment, the entire sewerage and sullage as well as the solid waste from surrounding areas drained into it. It was being extensively used by the Dhobies (washermen) to wash clothes. The washing activity involved the use of detergents and soaps to the tune of one metric ton per day which released chemicals in the water in a dissociated form, and which, on reaction with water, deteriorated the water quality. Besides this, Dhobi families had constructed their houses and shanties on the bank of the lake and even in the water itself at some places resulting in the inflow of all the sewage, solid and liquid wastes

along with several other discarded materials directly into the lake. The families also possessed livestock i.e. donkeys, goats, buffaloes, and cows for professional and personal use with a sprinkling of poultry at places. A large quantum of nutrients thus entered into the lake directly."[47] The Lower Lake of Bhopal city was heavily polluted and additionally exposed to the daily inflow of toxic untreated city sewerage.

With the environmental integrity of the lake being seriously threatened and with health risks to nearby residents and users increasing, action was required. Consequently, limiting the pollution from Dhobighats (washing bay) on the Lower Lake was established as an urgent priority in the Shoreline and Fringe Management Program of the Bhoj Wetland Project. The goal, simply stated, was to prevent the pollution of the Lower Lake from the detergents, chemicals, and ashes flowing from the washing bay and related activities by rehabilitating them downstream away from the catchment area of the Lower Lake. Implementation of the project fell under the authority of the BMC (Bhopal Municipal Corporation). One of the projects identified under the Bhoj Wetland Project was to limit the pollution source by relocating this community by voluntary agreement. The implementation was assigned to the urban local body, the BMC. Surveys undertaken in 1995 identified 128 families living on the shores of the lake and another 100 persons, identified as squatters, with no leases yet continuing to occupy and utilize the land adjacent to the lake shoreline.

A round of public meetings were arranged through the NGOs for creating public awareness on the necessary yet still contentious relocation plan. The NGOs acted in a mediation and advisor capacity between the project and the Dhobi community. The union for the washerman community were understandably concerned about the impact upon their earnings and families. The Union of Washermen finally rendered their consent to the relocation program in October 1998. The movement of washing activity from the washing bay at Kilol Park and Khatlapura has relieved the Lower Lake of a daily pollution deluge of approximately one metric ton of soaps and detergents. The resettlement of the slums that were formally located on the lakeshore has eliminated the occurrence of direct pollution in the lake from sewage, wastewater, and solid waste inflow.

A report on the relocation program noted that, "Initially their union wanted to be relocated to sites in prime residential property. After a series of negotiations the union finally agreed to take the sites offered to them in 1998, which were comparable to the land they had in possession

and was partially government land, located downstream of the Lower Lake and hence non-polluting. Some of their conditions regarding leases for the new plots, financial help in construction of new houses and setting up a new washing bay as per their directions were accepted. Construction activities started in 2002. They were taken to the construction site to familiarize them with the new location and suggestions given by them were often incorporated. Regular monthly meetings were held by BMC officials to sort out any problems. Compensation packages were worked out. The new sites included roads, electricity, washing platforms and clean water and sanitation so that the community now enjoys a superior quality of life compared to their original settlement. After initial teething problems there have been no complaints to date while the source of pollution has been completely eradicated from the Lower Lake. The area vacated by them has been developed as a park adding to the aesthetic beauty of the lake."[48]

In sum, the Bhoj Wetland Project represents a pragmatic, cooperative, and highly effective solution to a severe case of lake contamination that was exacerbating pollution and health levels daily. Moreover, reports indicate that the living conditions of the washermen have improved at the new rehabilitation community in the form safe drinking water, clean water for washing, and improved sanitation.

Source: Aniruddhe Mukerjee, "India: Relocation of a washing community to reduce urban lake pollution #245," 2005.

Rainwater Harvesting

The benefits of RWH (rainwater harvesting) are substantial. It can increase crop productivity, food supply, health, and income. It can provide water for domestic and agricultural use that is safe. It alleviates water stress and overuse of traditional water sources such as lakes and streams. Particularly in low income and impoverished communities, it is a safe, low cost and easily implemented technology. The training needed is quite basic. RWH for home consumption can be installed at the dwelling thus dramatically increasing convenience and safety. Studies conducted by the UN reveal that women and female children are the primary water carriers in the rural areas. This chore, which is often physically demanding, can also be dangerous as many females are attacked during the journey to collect water. The process of RWH is technologically simple and financially of low cost, even for poor households. Essentially, RWH involves capturing water on rooftops or other clean surfaces and funneling the water into storage containers. It

is important to store water that is not polluted. The roof or surface area must be maintained to ensure cleanliness. It is also important to store the water in containers that are closed to sunlight and protected from dirt and debris. Sunlight and polluted air can damage water quality. Water in clean, closed containers can be safely stored for up to six months.

RWH can also be implemented at public buildings in both the rural and the urban areas. Water is becoming more inaccessible in many regions and also exposed to many pollutants, even in the rural areas. The urban water sources are facing increasing population pressures and pollution in large centers such as Mumbai, Delhi, and Calcutta. Evidence of groundwater depletion is well established in India. Moreover, there is a well-documented health burden from polluted water use. Thus, from a health, economic, environmental, and sustainability perspective, RWH is a remarkably simple yet powerful solution for safe water provision and irrigation support.

RWH construction is rudimentary yet simple. Basic needs and construction include the following elements:

1. A catchment area: The catchment area could be a roof surface which is the most common surface used. However, pavement has also been used. Metal roofs are ideal however any roof surface that is clean will suffice.
2. A system for funneling the water into safe, enclosed containers is required. A gutter system (gutters or pipes) needs to be installed that takes the water and transports it into the storage container.
3. Leaf and debris screens are necessary. Screens or mesh are essential to keep leaves, dirt, debris away from the gutters.
4. The water storage container can be made of wood, metal, plastic, fiberglass, or concrete.

The amount of water that can be captured from a simple RWH devise is substantial. For example, after calculating the meter or square footage of the total catchment area one can multiply that figure by 0.6 gallons of water per column inch of rain. If a dwelling, for example, has 500 square feet of roof available; then 500 x 0.6 = 300 gallons of rainwater per column inch of rainfall. RWH is extremely convenient and can provide water in the dwelling location or nearby vicinity.

There are multiple benefits to RWH:

1. It is safe for the environment
2. It is an easy method of augmenting or supplying water needs from a safe source.

3. RWH is an excellent solution to meet water needs in water scarce regions with low water reserves
4. It is cost effective, particularly for low-income households
5. Water areas with inadequate water resources can be partially replenished

"Rainwater can be harvested in a location where the rainfall is around 1000 mm or 39.4 inches (Bangalore receives around 1000 mm of rainfall annually). The amount of rainwater that can be harvested from the available rainwater in the plot depends on potential rainfall, catchment area available, collection methods and its efficiency."[49]

There is evidence to demonstrate that village-scale RWH will yield much more water for consumptive use than large or medium dams, making the latter a wasteful way of providing water, especially in dry areas. In the Negev desert, where rainfall is only 105 mm annually, it was found that more water is collected if the land is broken up into many small catchments, as opposed to a single large catchment.[50] This is due to the fact that small watersheds provide an amount of harvested water per hectare which is much higher than that collected over large watersheds, as evaporation and loss of water from small puddles and depressions is avoided. About 75 percent of the water that could be collected in a small catchment is lost at the larger scale. It is important to recognize that the non-harvested water does not necessarily go to waste, as it is returned to the water cycle from the landscape.[51] Other studies conducted by the Central Soil and Water Conservation Research Institute in Agra, Bellary, and Kota, and another one completed in the high rainfall region of Shillong, have determined that smaller watersheds yield higher amounts of water per hectare of catchment area. Thus in a drought-prone area where water is scarce, 10 tiny dams, each with a catchment of 1 hectare, will collect more water than one larger dam with a catchment of 10 hectare. However, critics have suggested that the benefits of smaller RWH systems versus large-scale downstream implementation is mostly an effect of different scale and project implementation, and lack of consideration of (negative) externalities.[52]

The benefits of RWH in India, where water security is increasingly threatened, is monumental and has the potential to substantially expand water provision and save thousands of lives. The benefits alone in terms of health protection from waterborne diseases are extremely positive. "Amongst the proponents of rainwater harvesting, the argument in favor of its potential to drought-proof India has developed so far as to prove that, if half of rainfall is captured, every village in

India can meet its own domestic water needs."[53] Droughts appear to have a limited impact when farmers are equipped with RWH systems. Water harvesting and supplemental irrigation was economically viable at the national level and would have limited impacts downstream during normal years.[54] Thus India, faced with the mounting pressures of water scarcity, declining water tables, drought, water pollution, and population pressure, can look to RWB as a safe, low cost, ecologically sustainable practice to enhance water security, particularly in rural regions.

Profile of Rajendra Singh

Rajendra Singh is a leading Indian environmentalist and founder in 1975 of the NGO, Tarun Bharat Sangh (TBS). In 2015, he won the prestigious Stockholm Water Prize. Other awards include the Magsaysay Award for community leadership in 2001 for his innovative work with community projects on water harvesting. TBS is based in the village of Kishori-Bhikampura in Thanagazi tehsil, near the Sariska Tiger Reserve. The NGO has multiple achievements including: fighting the powerful mining lobby and their polluting effect upon water sources; assisting villagers with effective water management in their semiarid areas, which are close to the Thar Desert; increased use of johad, rainwater storage tanks. Since 1985, TBS has assisted in the construction of thousands of johads and other water conservation structures to collect and store rainwater for the dry seasons. The TBS is also credited with environmental initiatives that have remarkably improved and restored water quality in the Rajasthan, Arvari, Ruparel, Sarsa, Bhagani, and Jahajwali Rivers.

In 1985, Rajendra Singh, inspired by Gandhi, ventured to live in the dry and arid area of rural Rajasthan. His goal was to introduce modern education and medicine to the impoverished area. However, his work in the area quickly brought forth the realization that clean water was the primary concern of villagers. Water quality, water access, and river regeneration became a major focus of the work of TBS. Over the years, the arid landscape in many parts of the region have been transformed into lush, green areas of productivity. Over the past 29 years, 7 entire river systems, previously dried up for 80 years, were revived. Moreover, 10,000 Johads (small earthen dams) were built by the villagers at strategic places. Underground aquifers were recharged, rivers began to flow again, and food supplies were secured thus helping many

villages to become thriving communities again. These sustainable and valuable projects are being replicated across India.

The community engagement initiatives put forth by TBS includes: work with Village Councils, which are a traditional organization comprised of representatives from each household; developing a commitment to maintenance; facilitating community-driven decentralized water management and conservation; encouraging disciplined use of natural resources; ensuring sustainable water availability; creating an increase in agricultural and milk production; restoring area ecology; regenerating healthy, prosperous communities and strengthening democracy/political transparency and changes in government practices.

TBS is also dedicated to river health and sustainability. The river is seen as a physical and spiritual center of life. Through their valuable work, they address two separate and vital universal problems: (1) communities everywhere are losing the capacity and will to fend for themselves; and (2) communities are increasingly threatened with shortages of natural resources, even in the developed world. The work of TBS has revived numerous rivers. In 2009, Rajendra Singh led a *pada yatra,* (walkathon) with environmentalists through Mumbai along the endangered Mithi River. In January 2014, Mr. Singh conducted a *parikrama* (refers to the circumambulation of sacred places in Hindu, Jain, or Buddhist culture) along the banks of the Godavari River, from Trimbakeshwar to Paithan, to convince people to combat river pollution. Mr. Singh is a member of the NGRBA (National Ganga River Basin Authority) under the Indian government's Ministry of Environment that was established in 2009. Rajendra Singh is the Water Laureate for 2015. He is also the chairman of TBS India and The Flow Partnership in the United Kingdom.

Interview with Rajendra Singh

Please describe the current climate-change situation in India.

The monsoon in India is becoming increasingly erratic. When the time to sow comes—there is no rain. When the time to harvest comes—there is too much rain, leading to crops rotting and hence a loss in productivity coupled with a steep rise in prices of grains and food. This impacts the middle class the most and quite hard. Being an agricultural society, India depends on the stability of the monsoon to produce a good harvest and have food security. All changes in the monsoon impacts the marginal and small farmers the most.

What are the significant barriers to water quality and health and what is the 10-year outlook?
The biggest barrier to water quality is the pollution of the rivers of India. Irresponsible industrialization and the release of effluents in our rivers is increasing the pollution of the rivers. Because of polluted rivers, ground water is also becoming contaminated. Our agrarian society drinks that same contaminated water as well as uses it to grow their harvest. This in turn poisons and impacts their health and quality of life. If we do not save the rivers and clean them up, then it will be a problem spanning generations, not just the next ten years. We need to link people to their rivers and make them take responsibility for keeping them pure, clean, and alive.

What policies is the national government developing or conducting to guard against climate-change effects?
Integrated watershed management and rain water harvesting is a policy and strategy for climate-change adaption being adopted by the National Government of India.

What policies would you like to see the national government introduce to protect against climate change and drought?
There are plenty of existing environment policies in India. What is needed is a strict enforcement of the same. A few policies that will benefit with rigorous enforcement are:

- A River Policy where encroachment and pollution can be halted
- Rain water harvesting with community involvement
- Natural resource management and protection

Describe major priorities for TBS for the next five years.
Nationally TBS wants to focus on efficient use of water in agriculture so that there are more crops per drops. It wants to focus on Increasing Water Productivity. Internationally and nationally, TBS wants to awaken people's consciousness and realization toward wise water usage so that future generations are the beneficiaries not the victims of our mismanagement. Current generations should not forget that sustainability for future generations is our moral responsibility. TBS is also now focusing very actively on sanitation issues which often occur due to a scarcity of water.

A reflection on the work of Tarun Bharat Sangh:

When we started the work, we were only looking at the drinking water crisis and how to resolve that. Today our aim is higher. This is the 21st century. This is the century of exploitation, pollution and encroachment. The current exploitation of water that is happening, the pollution of water that is happening, and the encroachment on water structures that is happening, to stop all this, to give new life to rivers, and in this century, the war on water that we can see, to convert that into peace, that is my life's goal. So these world water wars that are on our doorstep, I am working to convert that into world peace. To do this, nationally and internationally, we have started a movement linking water and people encouraging them to conserve water as well as to use water efficiently. On one side, we are looking at water conservation, and on the other, improving the efficiency of water utilization. With this water conservation, there will be prosperity, and efficiency of water usage will increase. This wastage of water and its misuse will stop.[55]

CHAPTER FOUR

Indonesia: One of the Most Polluted Countries in the World

Country Overview

Indonesia is a rising economic power that is characterized by extremes of wealth and poverty. According to water development experts, Indonesia has the worst drinking water in Southeast Asia and there are wide gaps between the urban/rural water access and water quality. Indonesia is the world's fourth most populated country. It is a diverse country that stretches over 17,504 islands. The water access and sanitation situation is generally improving yet inadequate in many areas. In 2012, 93 percent of the population had an improved source of drinking water in the urban areas. In the rural areas, the figure is 76 percent. Sanitation coverage is less comprehensive with 73 percent of the urban population and 44 percent of the rural population utilizing an improved sanitation source.

Major health, economic, and water indicators

Human Development Index (HDI) for Indonesia, 2014: 108
Population, 2014: 249.87 million
Gross national income (GNI), 2012: USD 3395.00
Life expectancy, 2012: female: 71.8
male: 68.3
Improved rural water source, 2012: 76 percent
Population percentage with access to improved sanitation, 2013: 54 percent
global average: 72 percent
Rural population, 2012: 48.5 percent

Poverty index, 2013: 11.4 percent
2012: 12.0 percent
Homeless population, 2014: 0.774 percent
Carbon dioxide emissions per capita (tons), 2014: 1.8

Since 1995, 24 percent of the national population gained access to improved water sources and 25 percent of the population gained access to improved sanitation. Although these are encouraging national improvements, there remains a protracted problem of uneven social and economic development and serious inequities experienced by the urban and the rural poor. Moreover, considering the fact that nearly 46 percent of Indonesia's population lives in the urban centers, and the figure is rising each year, the protracted problem of open defecation, calculated at 14 percent among the urban dwellers, is a serious health concern. Indeed, one of the great challenges facing the country is the low percentage of waste disposal and treatment. Globally, health and development experts continuously stress the important link between clean water, sanitation, and effective waste disposal systems. This is a crucial health and development matrix. Yet progress in this area is inadequate in Indonesia, thus figures on improved drinking water sources are misleading because they do not accurately reflect the total development picture. Alarmingly, only 1 percent of the urban wastewater and a mere 4 percent of sewage is treated.

For Indonesia, total internal renewable water resources are approximately 2018 cubic kilometres per year. Surface water resources are estimated at 1972 cubic kilometres per year. Water quality is not the problem for Indonesia, the problem rather rests with how it is distributed, stored, and piped. Experts calculate that about 30 percent of surface groundwater resources are usable. Indonesia has a higher withdrawal rate for agricultural irrigation at 82 percent compared to most countries that typically utilize about 70 percent. According to the Asian Water Development Outlook for 2013, based upon a five-point scale; 1 = low and 5 = excellent, Indonesia ranks as follows: Household Water Security = 2; Economic Water Security = 4; Urban Water Security = 2; and Environmental Water Security = 3.[1]

The Indonesian government's Water Resource Management Policy Reform process has focused upon the following serious water and sanitation problems facing the country.

(a) Water allocation is under local scarcity due to growth of nonirrigation water demand;

(b) Inadequate urban access to piped water supply;
(c) Water pollution and adverse impacts of untreated municipal wastewater discharge including industrial and mining effluent disposal;
(d) Adverse impacts of watershed degradation such as increasing flood peaks causing economic damages, deceasing dry season flow, and sedimentation damages to water infrastructure.[2]

Each of these reform initiatives involve a major commitment at the state and national level and budgetary resolve.

Jakarta: City Water Profile

Jakarta, with a history dating back to the fourth century AD during the Sundanese kingdom, is the largest city in Indonesia. The current population (2014) is 9.8 million although the entire metropolitan area population is close to 28 million. Jakarta is one of the fastest growing cities in Asia and the world with an annual growth rate hovering above 3 percent (2012). The city is located on the northwest coast of the island of Java. Despite recent improvements in the urban water supply, serious quality, health, and access gaps persist. The exponential population growth and rising demand for basic services including water and sanitation have placed severe strains on city capacity and budgets. The water supply for Jakarta was privatized in 1998 with two private companies controlling the water distribution concessions on the basis of 25-year leases. Paly Ja supplies the western part of Jakarta while Aetra supplies the eastern portion. The water utilized is derived from the Jatiluhur Reservoir that is located on the Citarum River that is 43 km southeast of Jakarta. Critics of water privatization in general and the service/quality delivery in particular have an arsenal of valid complaints. In Jakarta, water utilities supply piped water to about 17 percent of the total population. Since tariffs are too low to recover costs, the maintenance of the water infrastructure is poor and therfore results in a high rate of leakage, about 50 percent.[3] Approximately 40 percent of residents do not receive piped water and only 2 percent of residents have access to piped sewage systems.[4] A common source of water for millions of residents, largely poor, is the shallow wells. Yet studies have shown that approximately 80 percent of the wells contain high levels of fecal and bacterial contamination. A United Nations report released by UN Habitat, estimated that 25 percent of Jakarta residents live in slums, or *kampungs* as they are known, another 4 percent of the urban

citizens live along river banks or by flood plains.[5] Safe water and proper sanitation are chronic problems in the *kampungs* for millions of Jakarta's poor.

A recent study on water supply in Jakarta noted that "Jakarta's population includes a significant number that live in wretched, unsanitary conditions with no access to clean water services. In these conditions people are forced to choose either to draw water from heavily polluted rivers, contaminated and often saline aquifers, or when no mains water is available, purchase it from private pushcart vendors at the price of US 0.15 per 20-liter jerry can or US $7.50 per m^3, which is more than 70 times the price of mains water if it were available."[6] Water used in Jakarta from the Jatiluhur Reservoir is not safe and leads to multiple incidents of waterborne disease. "The water flows through agricultural fields to reach Jakarta via a 33 km open canal. Along the way, some water is drawn illegally by farmers for irrigation use and water is also contaminated from people defecating into the canal and from rudimentary toilets that pour untreated waste into the canal. By the time the water reaches Jakarta, it is of poor quality." [7] Accordingly, millions of impoverished Jakarta residents are victimized by exorbitant pricing, contamination in their water supply and frequent episodes of illness due to waterborne disease.

Water supply and quality are not the only serious environmental and health problems facing the residents of Jakarta. The sanitation system in Jakarta, indeed in the entire country, requires a massive overhaul and modernization. In 2012, only 12 cities out of 98 municipalities in Indonesia had centralized sanitation systems. In Jakarta, the 2 percent of city residents that have access to a proper and efficient sanitation systems are found in the upper-scale business districts, hotels mostly catering to foreigners, expensive apartment complexes, and some houses. Weak government environmental standards and lax enforcement combined with poor oversight result in the deliberate and chronic dumping of toxic chemicals, contaminants, and human waste into water systems and lands that ultimately pollute the fragile water supply and ecosystem. Most sludge from emptied septic tanks is dumped illegally, usually into waterways, due to inadequate treatment facilities or regulations for sludge management.[8] Nearly 25 percent of the estimated 28 million population live in slums and serving these impoverished inhabitants with safe sanitation systems and clean water supply is a challenge that the government is far from meeting even at minimum standards. According to a Water and Sanitation Hygiene (WaSH) program report on the situation in Jakarta: "providing sanitation for these populations

is challenging not only because of physical characteristics such as flood prone land and dense occupancy allowing little space for latrines with simple capture and treatment technologies, but also because institutional, social and economic factors such as the illegal status of communities, communal priorities, and the inability to qualify for government subsidies."[9] Of eight major cities in the Asia region, Dhaka, Delhi, Ho Chi Minh City, Kuala Lumpur, Manila, Phnom Penh, and Vientiane, Jakarta has the second worst level of sewage coverage at 2 percent after Vientiane.

Health and Human Rights Challenges

Since the United Nations General Assembly in 2010 passed a resolution declaring water to be a "human right," there has been a greater and much needed focus upon a range of water rights and development issues. The unfortunate reality for Indonesia is that millions of marginalized and economically deprived citizens are not accessing clean, safe water nor the subsidiary right of sanitation. Within the international human rights community there is clear recognition that water rights and sanitation rights move forward in tandem. This view is certainly expressed in the work and priorities of major international organizations such as the United Nations and multiple agencies including UN Water and the WHO (World Health Organization). The World Bank operates the notable WSP (Water and Sanitation Program) that develops, partners, and funds water access projects and sanitation systems in the developing world.

The expression of rights in the international system and indeed international law is not tantamount however to effective enforcement. One of the great challenges in human rights development is the enormous gap that exists between international law and enforcement. With regard to water rights, inclusive and humanitarian laws are a vital first step but the important and tangible work lies in bringing those laws into common and sustained practice. Since water is fundamental to life and health, the absence of safe water leads to a host of severe and sometimes fatal waterborne diseases. The WHO has estimated that 9.1 percent of the disease burden globally is attributable to unsafe water, inadequate sanitation, or inadequate hygiene.[10] The data on waterborne disease does not however fully account for the terrible human cost in terms of illness, lost work days, lost school days, rehabilitation time, economic costs for medicines and treatment that is often financially unsustainable

for the poor, and of course the ultimate tragedy of fatality that affects millions. The general water rights situation in Indonesia is critical and lacking in basic protections that further exacerbate national health and development. Article 33 of Indonesia's 1945 Constitution states that "The land, the waters and the natural resources within shall be under the powers of the State and shall be used to the greatest benefit of the people."

Many analysts have described Indonesia as having among the worst water quality in Asia. Several cities and towns have inadequate and unclean water sources that have reached critical levels. In the city of Pekanbaru, only 30 percent of the residents have access to clean water and that number drops to 10 percent in the villages.[11] Waterways, canals, and rivers are often contaminated with raw sewage and toxic waste from industries. Indonesia is fully committed to the United Nations Millennium Development Goals established in 2000, yet did not meet a major MDG 7 target in 2015 with less than 50 percent of the population having sustainable access to an improved water source. With respect to child protection and health, unhealthy water and poor sanitation contribute to 50,000 child deaths each year in the country. The WHO has reported that diarrhea is a major cause of child illness and death in the developing world and many of the diarrhea infections are caused by unsafe water. In 2014, diarrhea ranked as the second highest cause of death among children under five years of age.

The extent of infectious disease in Indonesia is ranked as very high. Food or waterborne diseases in the country include bacterial diarrhea, hepatitis A, and typhoid fever; vector-borne diseases include dengue fever and malaria.[12] Food and waterborne diseases are commonly acquired through eating or drinking. Water contact diseases are usually acquired through swimming, bathing, or standing in freshwater lakes, streams, and rivers. The vast majority of diarrhea cases are gastrointestinal infections that are caused by bacterial, parasitic, and viral pathogens. Diarrhea typically causes a loss of bodily fluids. In chronic cases it can lead to dehydration, weakness, and in many cases death. Dehydration is the cause of approximately 90 percent of deaths from infectious diarrhea. In many impoverished communities, such as the slums of Jakarata, repeated bouts of diarrhea are common. This is a serious health concern because the body of the patient becomes weakened and susceptible to other infections and illnesses. Children are particularly susceptible to health complications because their immune systems are not fully developed. Moreover, children living in poverty and conditions of severe underdevelopment are already exposed to a

harmful and debilitating health environment. Hepatitis A is a viral disease that causes liver inflammation. Typhoid fever is a disease caused by the *Salmonella Typhi* bacteria. It is contacted through contaminated food, water, and unsafe sanitation. Vaccines against *Salmonella Typhi* are considered to have a protective rate between 50 and 75 percent and previous exposure does not preclude further infection. Dengue fever is a viral disease. It is transmitted through the bite of an infected *Aedes aegypti* mosquito. Previous exposure to Dengue fever does not protect against further infection and there is no current vaccine. Malaria is a common affliction in the country. Malaria is caused by infection of the red blood cells with *Plasmodium sp. parasites: P. falciparum, P. vivax, P. ovale and P. malariae*. Exposure occurs from the bite of an infected *Anopheles* mosquito.

From a global perspective, the vast majority of disease and fatality caused by bacterial diarrhea are the result of *E coli, Shigella, V. cholera, Salmonella, and Campylobacter* infections, bacteria has a strong association with poor sanitary conditions and are exclusively transmitted by the fecal–oral route; moreover, the burden of bacterial diarrhea is located almost exclusively in developing countries where they have been found to be responsible for about 50 percent of the cases of acute diarrhea. [13]

Water Contamination: Arsenic Case Study

Contamination of drinking water sources with chemicals is another serious health threat facing the Indonesian population. In particular, there is a growing body of evidence to indicate that substantial levels of arsenic contamination exist in water sources used for human consumption. Inorganic arsenic found in groundwater is a naturally occurring geologic phenomenon. Arsenic is found in soil, rocks, food, and the environment. The problem with arsenic is that it is exceedingly difficult to detect and highly soluble in water. The adverse health effects, with varying degrees of intensity depending upon the level of exposure, include: melanosis (pigmentation), keratosis (dry skin patches and legions), and damage to neurological, respiratory, hematological, and cardiovascular functions. "Hundreds of millions of people, mostly in developing countries, daily use drinking water with several times higher arsenic concentrations than the reported limit of 10 ug/L of water set by the World Health Organization. WHO, the U.S. Environmental Protection Agency, the International Agency for Research on Cancer, and many other health bodies report that arsenic in drinking water could cause skin, liver, lung, bladder and kidney

cancer. Low concentration of arsenic in drinking water is also a health hazard for a long duration of exposure."[14]

The process of naturally occurring arsenic contamination results from the rise of geothermal water to the surface and its interaction with rocks. Geothermal water is composed of high levels of arsenic and heavy metals. "In Indonesia, there are about 251 potential geothermal energies distributed in 26 provinces which can be a potential natural source of arsenic. High concentrations of arsenic have been reported in caldera of Kawah Putih, West Java, of up to 1170 ug/g. Recent groundwater investigations in the lowlands of the South Sumatra have indicated that an area of nearly 100,000 km^2 is vulnerable to arsenic contamination. Moreover, an analysis of 102 randomly selected wells located in the Holocene swamp deposits revealed arsenic concentrations above WHO drinking water guidelines with a maximum of 65 ug/I. These ground waters also sampled high levels of manganese, selenium and boron."[15] Further risk assessments of groundwater in South Sumatra and North Sulawesi provinces have indicated levels above WHO safety guidelines.

Sanitation: A Critical Health Right

The right to clean water for Indonesians cannot be fully achieved without parallel national and regional government action toward safe and efficient sanitation. Currently, government initiatives in this critical area are inadequate thus compromising the health and development of millions of Indonesians. A major area of public policy criticism against successive governments has been the failure to properly address the sanitation crisis. The current urban sewerage coverage of 2 percent is one of the lowest levels in the world and clearly incompatible with the urgent health needs of a growing population of 246 million people. Approximately 14 percent of the urban residents still practice open defecation, a situation that leads to a multitude of severe health, contamination, and sanitation problems. Although access to improved sanitation in urban Indonesia was about 73 percent in 2010, this only takes into account the basic criteria of access to a facility as defined by the WHO JMP (Joint Monitoring Program) and not safe collection and disposal of wastewater and septage, which is only 1 percent and 4 percent respectively. This coverage is significantly lower than other East Asian countries, despite Indonesia having experienced significant economic growth in recent years, surpassing many of its neighboring countries.[16]

Moreover, a study conducted by the World Bank WSP reported that Indonesia lost an estimated IDR 56 trillion (USD 6.3 billion) in 2007 from substandard sanitation and hygiene. Estimates suggest at least 50,000 sanitation-related deaths in 2007. Untreated wastewater and sewage flowing into water ways and seeping into the soil causes ecological degradation in addition to well-documented health hazards. A National Policy and Strategy for the Management of Wastewater Systems was promulgated in 2008 with an implementation framework for 2010–2014. One feature of the National Policy is the construction and completion of piped sewage systems for 15 cities, thus providing 20 percent of these populations with piped sewage coverage. Despite the massive development challenges facing the country, there are some notable projects underway to improve sewage disposal systems. The National Government Medium Term Development Plan (RPJMN) for 2010–2014 calls for the following targets to be achieved: (1) Indonesia to be 100 percent ODF (Open Defecation Free); (2) Ten percent of the population to use off-site waste water management systems or community managed simplified sewer systems with communal septic tanks known popularly as DEWATS; (3) The remaining 90 percent of the population will have access to improved on-site private or communal sanitation systems. Under the DEWATS program, the expectation is that 10–15 million people will be covered. The calculation is that 80–100 people will be able to utilize each system.

Environmental Challenges

Global consciousness about environmental protection is an important step forward and one that is slowly taking hold in developing countries such as Indonesia. The work of the Indonesian NGOs, government departments, stakeholders, and concerned citizens is having an effect though much remains to be done. In general, the quality of water in the country is in distress, which dramatically affects health and development for the current generation and future generations, unless substantial and sustained action is taken.

The rapid population growth in Indonesia, averaging about 6 percent in the last decade alone, has placed strains on water sources, lands, human settlements, and health services. The capacity to absorb the growing urban populations for instance has challenged water and sanitation capacity. Moreover, rapid industrialization and the drive for

profit in a capitalist, market-oriented economy have led to industrial pollution on a scale that is deemed hazardous to human health in many regions of the country. A comprehensive study by ESCAP noted the following problems facing the country from moderate to severe levels: deteriorating water quality, flood risk, cyclone risk, drought, elevated ecosystem climate-change risk, and poor access to drinking water and to sanitation.[17] Another serious environmental problem is the increasing level of pollution in major river ways in the country including the mighty Citarum River. According to the River Health Index, approximately 80 percent of the rivers in Southeast Asia are in poor condition and Indonesia is ranked as a major river polluter. Three recent cases reveal the important intersection between the environment and economic development. The city of Denpasar had difficulty attracting tourism because of polluted beaches and inadequate drainage facilities particularly during the monsoon season; in Cimahi, the local government intended to attract clean industries but recognized that polluted drains and rivers discouraged potential investors; in Pekanbaru, their reputation as one of the cleanest cities in the country was threatened by the risks associated from chronically polluted rivers and an unhealthy and unsanitary drainage system.[18]

Climate change is already exposing the country to adverse health, environmental, ecological, and economic costs. One of the leading risks for Indonesia arising from climate change is flood control and management. Regions in Indonesia that are south of the equator are expected to experience shorter rainy seasons with heavier rainfall and higher than normal flood risk. "Mean sea levels have been observed to have increased between 1–8 mm per year in different areas, increasing the risk of salt intrusion of coastal water resources. Climate hazards have also increased significantly over the past 50 years leading to flooding, landslides, and water-or vector-borne diseases."[19] The risk of lowland areas flooding is quite substantial. The Intergovernmental Panel on Climate Change has predicted that by 2100, sea levels will rise between 0.09 and 0.88m thus increasing flooding damage at substantial levels in many parts of Asia including Indonesia. Low-lying areas, cities, rice fields, and lands will be in danger of water submergence. Sea coasts will be affected by global warming in multiple ways. According to a 2002 study by WRI, 43 percent of the coral reefs in Indonesia are threatened from climate change.

The June 2014 Indonesian Environmental Status report published by the government noted that 82 percent of the 52 rivers surveyed in the study were polluted with industrial and domestic waste. Among the

more distressing findings are "decreasing water quality in the country's rivers, particularly in Riau, Jambi, Central Java, East Nusa Tenggara, Southeast Sulawesi, and Maluku. Rivers are primarily contaminated with e-coli bacteria, from human waste, which indicates the poor quality of waste water management and treatment in cities and villages. Moreover, approximately 53% of the population pours domestic waste from bathing, cooking and washing into rivers."[20] Although septic tank installation at homes increased by approximately 20 percent over the last decade, the government can only process 5.4 percent of domestic waste.

Citarum River

The Citarum River Basin in Bandung, West Java covers an area of about 13,000 square kilometers. It is a major river way that provides a water source for the 28 million residents of greater metropolitan Jakarta and 10 million residents of the Bandung Metropolitan region. The river is critical to the economic, water supply, and agricultural livelihood of the region, providing about 80 percent of the surface water to Jakarta's water supply system, irrigation for about 6 percent of Indonesia's rice production, and water for over 2000 industrial enterprises. A 2013 Asia Pacific Network for Global Change Research science bulletin noted the following contamination issues in the Citarum River: aluminum, manganese, and iron concentrations in the river of 97 ppb, 195ppb, and 194 ppb respectively, which are significantly above the EPA recommended levels for heavy metals in drinking water of 32 ppb for aluminum, 34 ppb for manganese, and 66 ppb for iron.[21] A major river that significantly serves the needs of 15 percent of the Indonesian population cannot remain affected by severe pollution and toxic contamination without incurring substantial health and economic costs. The most serious issues confronting river health include:

1. A clear pattern over the past 20 years of deteriorating river quality in the upper Citarum River and the essential parameters are far outside mandatory limits with more than nine times for biological oxygen demand and more than 5000 times for fecal coliform in some locations;
2. The impact of municipal solid waste discharged into waterways is from direct water pollution of organic and nutrient loads, blockage of waterways, negative aesthetic impact, loss of materials that have value such as organic wastes and plastics;

3. Water quality deteriorates substantially when passing through the upper Citarum River Basin. In Bandung City, COD, BOD, and *E coli* concentrations are alarmingly high. Organic pollutants (COD and BOD) are exceeding limits by a factor of three to ten. These high levels will result in oxygen depletion and anaerobic conditions of the water body which results in loss of biodiversity, odor, and black water. Coliform values exceed the limit by a large margin.
4. The major share of organic pollutants is from domestic–municipal sources, whereby the heavy metal pollution is from industry. Textile industries are known to discharge phenols and chromium. Chromium levels exceed WHO health guidelines by a factor of three.[22]

A World Bank WSP report estimates the cost benefit of improving water quality in the upper Citarum River at USD 279 million per year, 45 percent of the benefits are from health gains; 21 percent from time gains; 19 percent from reuse; 9 percent from reduced treatment costs, and 6 percent from land value increases. [23]

Government Water Policy and Laws

The Indonesian government is responding to water and sanitation challenges with a number of important initiatives. Although in many ways incomplete, they do represent important steps forward to ensure water and sanitation security. Article 5 of the Water Resources Law affirms that the State must guarantee individual access and availability of water for everyone residing within the territory of the Republic of Indonesia. Environmental protection is generally covered by Law No. 32 of 2009 on Environmental Management and Protection. Under the Law on Regional Governments (Law No. 32 of 2004, amended by Law No. 12 in 2008), regional governments have some autonomy and control with respect to the protection of the environment. Environmental law is under the authority of the Ministry of the Environment. The management and monitoring of water resources is under the auspices of the National Water Resources Board.

In Indonesia, provinces have technical agencies that are discharged with responsibility over environmental issues. The National Water Resources Board develops nationwide regulations and policies with respect to water resources. In an effort to increase transparency on

environmental policy and practices, the Environmental Law accords everyone the right to access information regarding environmental protection and management.

Additional important environmental and water management measures include:

(1) Article 5 of the Water Resource Law obligates that the State must guarantee individual access and availability of water for everyone residing within Indonesia.
(2) Based on Government Act No.82 of 2001, water quality is improved through the PROKASIH (Clean River Program) program that provides monitoring of water quality in the Citarum River, which serves a population base of 38 million people.
(3) A Comprehensive Water Resources Law was established in 2004.
(4) The Indonesia Sanitation Sector Development Program (ISSDP) has contributed to an eightfold increase in funding for sanitation since 2006. The goal is to provide assistance to a target of 330 cities.
(5) A new regulation on irrigation was issued in 2006.
(6) A law on flood management was enacted in 2007.
(7) Regulations on river basin management and watershed management were issued in 2008.
(8) A National Council on Climate Change was formulated in 2008.
(9) A National Water Resource (NWR) Council was established in 2009.

Water Development Project Profile

Rain Water Catchment Project, Reservoir Tank, and Family Cubang Rehabilitation in Muntigunung Sub-Village, Bali Province, 2008.

The major problem in Muntigunung is low accessibility to fresh water. Water availability is a function of a number of factors including poverty, technology, and pollution. People in this region typically migrate to other cities and then return to Muntigunung in the rainy season when they can plant crops such as corn and chili. To assist the residents with better water quality, the NGO YDD (Yayasan Dian Desa) conducted an intervention to solve the water

problem in Muntigunung. During the 2006–2008 period, a Rain Water Catchment Structure and Reservoir Tank were constructed in five kelompoks (Tiing Tali, Cangkeng, Klumpu, Asah, and Bangun Sakti). The Rain Water Catchment Structure is designed to capture the rain water and divert it into a reservoir tank via a pipe or gutter. They also assisted with the construction of family cubangs (water storage tanks) in every household and to rehabilitate many cubangs that were broken and leaking. The project required householders to agree to specific preconditions.

Preconditions

1. Family latrines were installed to elevate hygiene and reduce the disease risk. This precondition objective is essential to make the citizens realize the importance of environmental cleanliness. The YDD team checked every household to assure that their environment was clean. No project commenced until the household environment was deemed safe.
2. Participants were required to sign a "Resigning Agreement Letter" about land usage to build the Rain Water Catchment Structure and Reservoir Tank.
3. Participants were responsible to excavate a hole with size 8x7x3 m^3 for the Reservoir Tank.

Implementation

In each case, the YDD team selected the location to build the shelter and reservoir. Participants show the YDD team some locations but the YDD chooses the location to best meet technical and environmental specifications. The YDD then makes a sizing (8x7x3 m^3) and the participants have to make an excavation for one month. In the excavation process, the YDD always monitors the work. If the excavation size is right, the tank reservoir construction is started.

Family Cubang Rehabilitation

The majority of households in Muntigunung already had a family cubang but with simple construction and very low quality. The family cubangs helped the people in Muntigunung to meet basic water needs but water in their family cubangs is often contaminated thus increasing the risk of illness. In general, water in the family cubangs only lasts

1–3 months after the rainy season. After this period, they have to buy water which is expensive. The YDD rehabilitated many cubangs in the dry season.

Cubang Rehabilitation

To support family cubang rehabilitation, the owner of the cubang has to clean their circle (house and cubangs) from dirt, debris, and garbage. In addition, every owner has to clean the inner portion of the cubang from rubbish and moss. The YDD team checks the cleanliness of every cubang. If it met standards, the rehabilitation project proceeded. Cleanliness is essential for the effective functioning of the cubang.

Roof Installation

The majority of family cubangs in Muntigunung are covered by non-permanent materials such as coconut stem and palm stem. If the stem is dry, its dust will enter into the cubang and can cause browning of the water, dirt, and odor. Therefore, every family cubang has to be closed to cover the cubang from various dust (ash, foliage, plastic, etc.) and to catch rain water. The material used for roof installing is rafter construction and zinc.

Gutter Installation

Gutter installing is very important to collect rainfall from the roof of the house/building and immediately divert it to the family cubang. Usually, gutter installing is done with the assistance of the owner of the cubang. Generally, cubang rehabilitation, roof installing, and gutter installing require 3–4 days.

Through this innovative community development project, the YDD has been able to assist residents with a safe, eco-friendly, and simple technique for capturing rainwater.

Interview with Petrus Suryadiputra Swarnam, Director of Yayasan Dian Desa (YDD), Indonesia

Petrus Surjadiputra Suwarman was born in Palembang, Indonesia in 1952. He has a degree in civil engineering from Atma Jaya-Yogyakarta University. Mr. Suwarman has spent many years helping

underprivileged communities gain access to clean water and sanitation as the director of Yayasan Dian Desa NTT from 1982 to 2013. He was awarded the "Adam Malik Award" in Jakarta in 1986 for his contributions to the development of villages. Mr. Suwarman had also collaborated with international organizations such as UNICEF, SIMAVI (Netherlands), Asia Development Bank, and Oxfam in several clean water and sanitation projects. He is still currently involved in water rights work, working for the YDD at its headquarters in Yogyakarta. The YDD is an Indonesian NGO dedicated to water rights development and education. It was founded in 1980.

Describe the current water situation in your country in terms of health, access, and scarcity.
The situation regarding water in several islands in Indonesia varies. There are some places where it is very difficult to have access to water, for example, in my workplace in the province of East Nusa Tenggara/NTT. Clearly, the difficulty to obtain water will have a negative effect on the health of citizens. When the source of water is far from where the people live, it takes a lot of energy and time walking to obtain water. The lack of water also explains why they are unable to have proper toilets, resulting in them defecating anywhere they want. Clearly, there are many water sources, but the technical facilities are not yet there due to limited funds. Another option is to obtain water when it is raining but the people have difficulty trying to collect the rainwater.

What are the major waterborne diseases in your country and/or region where you operate?
To give you a picture of sanitation in Indonesia, 30.7 percent of Indonesians do not have access to adequate sanitation (MDGs report 2007). Only 60 percent of the population have access to toilets with improper sanitation facilities. (Coverage of sanitation facilities in Sikka Regency, East Nusa Tenggara province where I had worked in the YDD is only about 52 percent. In the rural places, the coverage is only about 29 percent. Incidence of diarrhea is about 280/1000 of the population. In Indonesia, diarrhea is the second highest cause of death for children under the age of five and the fifth highest cause of death for all ages of the population.

What are significant barriers to water health and access?
The main obstacles are the lack of a healthy lifestyle behavior, lack of concern to preserve water sources, and the cutting down of trees

everywhere results in the disruption of water sources. Sometimes, the distance between residential areas to the water source is far. People have to walk for many kilometers just to get 1–2 buckets of water which takes a lot of time and energy. Access to clean water is still far from being enjoyed by many residents

Describe any groups or minorities that face specific hardships regarding water access and health.
There are many cases in the area where I worked. One example of such a location is Palue Island, it takes 4–5 hours with a motorboat from Maumere city, depending on the waves. Palue Island is located on the Sikka Regency/District, East Nusa Tenggara province (NTT), there are 9 villages, 1 subdistrict and the number of residents is around 12,000. They do not have any access to a water source, they collect their water from rainwater and from steam coming out from the land crack along the Rokatenda Mountain by using bamboo. With their process of "distillation," they are able to obtain about 4–5 litres of water for cooking and drinking in 12 hours. How do they bathe? The residents sometimes bathe in the sea or bathe during the rainy season. Generally, when there is rain, people will seek shelter in their homes but In Palue Island, when there is rain everyone happily gets out of their homes to bathe as much as they like. It's strange but true.

What is being done to assist these groups at the national or local government level?
The government has made a lot of efforts but from our observations, all developments in Indonesia is like a "crescent". Starting from Sumatra, all of Java, Bali and ends in Makasar, Southern Sulawesi, so there are a lot of provinces that do not get covered by this development "crescent," which means that many people are still suffering. Maybe we need a "revolutionary action." Help from the government sometimes does not meet what people really need, for example, instead of building clean water and electricity facilities, the government builds roads that are not the main priority for people there.

What policies is the national government developing or conducting to expand water/sanitation health and access?
In 2008, the Ministry of Health of Indonesia introduced the STBM (Total community based sanitation) program. This does not involve any physical support, communities were only educated on how to adopt a more healthy behavior. This program has five pillars.

Pillar 1. Stop defecating anywhere without consideration.
Pillar 2. Wash your hands with soap, this is constrained if the village has no water. It's better to wash hands with sand or air.
Pillar 3. Household drinking water management.
Pillar 4. Domestic solid waste management.
Pillar 5. Domestic liquid waste management.
Collaborating with our foundation YDD, SIMAIV-Netherlands together with the government of Netherlands, have started a clean water project in 2010 (which finished in December 2014) in two districts, Sika and East Flores in the NTT province. I am not sure that the government of Indonesia can meet "MDGs, Healthy Indonesian 2014."

What policies would you like to see the national government introduce to improve water/sanitation access, quality, and health?
We still need funding and help from the central government. We agreed that the government doesn't need to give funds for physical facilities for several areas where the economy of residents is fairly good. However, for poor people living in our province (NTT), the poorest province among all 33 provinces in Indonesia, it is difficult to access clean water, and the more people become poorer the easier it is to get exposed to diseases. Ideally, the sanitation program is complemented by a clean water program, if not . . . means of sanitation without water . . . will contaminate and cause more diseases. Ideally, clean water and sanitation projects should be handled by experienced people or contractors. There must not be contractors who "play under table" with local officials to get the projects and in the end the facilities cannot be used by the people.

Describe particular challenges facing vulnerable children and minority children with respect to water access and health.
The biggest challenge in my opinion, is structural poverty, the result of the poor economy. Elders are inadequately educated, creating a lack of knowledge on healthy living. Sometimes children are exploited to work in gardens, carry firewood, look after younger siblings, and carry water. This poverty prevents them from being able to go to school, as they cannot afford it. Private schools are expensive while government schools have not enough teachers. In addition, today, many teachers have the mindset of not being proud to be a "teacher," it was different in the past when teachers had pride in their status. These children are

unable to live a hygienic lifestyle, they cannot wash their hands before eating due to the lack of access to water. Clinics are far away and there are shortages of doctors in the villages. This situation contributes to a high child mortality rate.

What environmental problems are impacting water quality?
The illegal plantations opened by local farmers contaminate the water sources. Besides chopping down trees and destroying forests, they also keep animals such as horses and goats close to the water sources, which causes the water to be contaminated by animal waste. The understanding of a hygienic lifestyle in the community is still poor. People use the water but they do not maintain the source of water away from contamination. People living in poverty for a long time will affect their environment.

What are the three major steps that could be taken in the future to improve the general water health and access situation?
Maintenance of clean water sources, primarily water sources from the forests. Continuous maintenance of the existing clean water facilities needs to be strengthened by rules and regulations. Facilities should be created by those who have the technical expertise, not made by any contractor. Experts who have been surveyed have also commented that it is important to not allow water facilities to be created which do not function properly. If the piping for example is inadequate, the water does not flow.

Describe two or three innovative water development or rights projects that are assisting people.
A comprehensive survey was conducted based on survey results, it can be determined that three kinds of facility will be built, if there is a water source on top of the settlement, piping that takes advantage of gravity can be proper, safe, and cheap. In areas where there are no water sources on the surface of the earth, the only source of water comes from the sky, specifically from rainwater, by building containers made from ferro cement. These containers have to be utilized efficiently, when residents have the funds and are able to build and maintain these technologies themselves, not being dependent on the contractor or the charity that helped them. Desalination, it is expensive but YDD has tried using it with a "Water Pyramid" in Pemana Island, Sikka Regency, and NTT with a grant from the Netherlands. Ponds are created with HDPE materials technology.

How important are the local NGOs and the international NGOs in protecting and advancing water rights and development in your country?
According to the 1945 Indonesian constitution, water, earth, and air belong to the country and should be managed for the welfare of the nation of almost 250 million people. To develop clean water facilities and sanitation by the international NGOs, which is very much needed in Indonesia, is an example of the cooperation between the local government, the YDD, the International NGO, SIMAVI-Netherlands in the Sikka regency and East Flores district with the local population. YDD regularly works with the World Bank, JICA-Japan, SDC-Switzerland, SDR-Switzerland, UNICEF, UNDP, USAID, AUSAID. The local government is very supportive and gives many opportunities for the international NGOs to provide financial and technological assistance, collaborating with the local NGOs, religious institutions, and of course the local residents, especially in contributing local materials and labor.

Describe your own background in water-related work and development.
My background was Civil Engineering (bachelor degree), working in YDD, which is specially engaged in the field of TTG (Practical Appropriate Technology) in the rural areas. I have a masters degree in engineering in the field of management construction. YDD has operated in the NTT province since 1980. I myself joined YDD-NTT from 1982 to 2013. The water facilities that we have been working on are: clean water piping gravity systems in 24 locations, 12,000 rain water containers made from ferro cement were built that can last for 30 years, and some of the containers were made from bamboo cement that lasts for only five years. Shallow drilling wells with pumps to raise the water level were built, and the latest was the "Water Pyramid" in Seman Island, Sikka-Flores-NTT, a desalination project in 2007.

Describe the importance of improved sanitation systems for health and water safety in your country or state/province.
The construction of sanitation facilities differs from place to place, and for locations with plenty of water, the main sanitation is a toilet with a septic tank system and bio pore absorbing holes. For areas where water is limited, a simple toilet (pit-privy/latrine) is made that does not pollute the environment. The hole is covered by using kitchen ash so that there will be no flies. The important thing when constructing sanitation or toilets is the base. They are made in such a way that they do not

pollute the environment further. For example, they are located at least 10 meters away from public wells. With the "septic-tank system" also, the important thing is locating its bio pore absorbing holes at least 10 meters away from community water supply wells. The type of sanitation or toilets for families is dependent on whether the area has a lot of water or if the area has limited water sources. Building them is not expensive if using local materials. If necessary, payment for building toilets can be made by installment (credit toilet) like the ones that have been organized by YDD from 2011 until now has been working well, cheap, practical, and ready for use within six hours. Cash or credit is allowed. Usually people pay with credit for houses, cars, and televisions but when our organization first tried the "credit toilet," people were laughing as they thought it was funny and strange. As time went by, they became more aware and gradually many of them were interested.

Describe major priorities in your own work and/or the NGO work you are associated with for the next five years.

The problem of water is a principal problem for every living thing on earth, including humans, animals, and plants. Our nonprofit organization tries to prioritize things. Providing the water facilities first, once they are built, other programs can be introduced such as health, agriculture, and farming. There are not enough water facilities available. To manage the facilities, residents set up OPAM (organisasi pemakai air minum), a water user group that collects fees. Another program is for drinking water, in addition to boiling water, Dian Desa has a program called SODIS (Solar Water Disinfection) by using mineral water bottle waste, since 1998, in collaboration with one of the research organizations in Switzerland, SANDEC–EAWAG. Training for behavior change toward a healthy life style should be evaluated and monitored. Training the village cadres so that they can help themselves is important along with finding partners such as the international NGOs in collaboration with the locals so that all programs can be continuously operated. Most important, people should be trained to be self-sufficient.

Interview with Muhammad Reza Sahib, National Coordinator, KRuHA, Indonesia

KRuHA is an Indonesian educational and advocacy NGO dedicated to supporting clean water development projects, educating the public on

vital water development issues, and working with the government and the NGO stakeholders on important water development initiatives.

Describe the current water situation in your country in terms of health, access, and scarcity.

The Indonesian population today is estimated at 230 million, 60.1 percent of the population is living on Java Island, which makes Java the densely populated island with 103 people per km^2. Most of Indonesia's rivers are heavily polluted, piped water management is unreliable. Indonesia is the best example of mismanaged water. Despite the fact that Indonesia is the world's fourth richest country in terms of water, only 30 percent of the population have access to a piped water network and most of it is undrinkable. The condition of the water resources keeps declining. Some of the most populated islands (Java, Bali, NTT, and NTB) have been in water scarcity conditions since 2002. About 70,000–100.000 children die every year due to water and sanitation-related diseases. There is no significant improvement in sanitation and waste water management since the colonial era (Jakarta, the capital of Indonesia has only 3 percent of the centralized sanitation system, 90 percent of the wells in Jakarta were polluted by E. coli bacteria as many septic tanks were located too close to the wells). Indonesia has the lowest percentage of urban sewage treatment among the neighbors the Philippines, Vietnam, and Cambodia.

What are the major waterborne diseases in your country and/or region where you operate?

Food or waterborne diseases: bacterial diarrhea, hepatitis A, and typhoid fever. Vector-borne diseases: dengue fever and malaria.

What are the significant barriers to water health and access?

Lack of government political will (the highest country expenditure on water and sanitation is only at 1 percent of the national budget), the trend of the county's development mode has been to totally ignore water.

Describe any groups or minorities that face specific hardships regarding water access and health.

Indonesia is at the crossroads of treating water supply as a public service or commercializing it through market or market proxy mechanisms.

The commodification of water occurs via land control (ownership). In this kind of situation, poor people who cannot afford to pay for piped water services and have no access to adequate land suffer the most.

What is being done to assist these groups at the national or local government level?
At the present moment, there is no significant effort from the government; the government often puts the responsibility onto private companies as their CSR. There were some initiatives to organize community based water management (named PAMSIMAS sponsored by the World Bank) in the eastern part of the country but mostly it was driven by donor agencies to apply what we called "hidden transactional cost." In the urban areas, where people depend on piped water systems, social tariffs are applied but discrimination happens.

What policies is the national government developing or conducting to expand water/sanitation health and access?
The main government policy is promoting PPP (Private Public Partnership) and corporatization of public services and utilities. They argue that huge funds are needed and the government lacks money so privatization and corporatization are applied to attract private investors. There are also many other technocratic approaches such as "one million new piped water connections" that never happened and there are plans to build several dams and a giant sea wall in Jakarta.

What policies would you like to see the national government introduce to improve water/ sanitation access, quality, and health?
Policies that are in line with the constitution and the human right to water and sanitation. We need mechanisms to put water back into the public domain and a genuine Integrated Water Management with significant public finance, involving the rights' holders (traditional users), limiting private involvement, and an integrated (resources, water and green areas, access, finance) public audit as a start.

Describe the particular challenges facing vulnerable and minority children with respect to water access and health.
Social and economic exclusion; no civil registration (communities that are considered as illegal settlements) will be the main challenges to access the system.

What environmental problems are impacting water quality?
There are several. Many kinds of developments are ignoring the water circle, there is massive deforestation for palm oil plantations, extractive industries, the lack of integrated sewage and sanitation systems, and poor waste management.

What are the three major steps that could be taken in the future to improve the general water health and access situation?

1. Comprehensive evaluation of the past and present approaches (including the evaluation of forest areas that have been granted for extractive activities, PPP projects, finance mechanism, land tenure policies and so forth).
2. Adding a significant government role (regulating, limiting third parties role, more public finance, the government should spend significant funds for capital projects such as infrastructure and reforestation).
3. Formation of a single-integrated governing institution, a Natural Resources and Water Ministry. There are too many government agencies dealing with water and very poor coordination among them.

Describe two or three innovative water development or rights projects that are assisting people.
Water that Kills, a video based project for raising public awareness that many people have no choice but to drink unclean water.

JPABK (Jaringan Pengelola Air Berbasis Komunitas), a community based water network in Central Java, consisting of more than 49 community based organizations for protecting and preserving local water resources by conducting regular cultural/religious activities in water catchment and watershed areas. Some of these community groups have also managed their own piped water system with better water quality and much more affordable water tariffs than what local municipalities provide.

Transparent Water Regulatory, a long process advocacy group demanding the water authorities in Jakarta to provide documents/informations on Jakarta PPP projects, piping installation, and financial projections in setting water charges and water tariffs. The process went through several mediation steps by the Public Information Commission.

Student's River Laboratory is an initiative and effort to restore river ecological capacity in East Java conducted by ECOTON.

How important are the local NGOs and the international NGOs in protecting and advancing water rights and development in your country?
The lack of government intention on water has led to a situation where poor communities living in eastern Indonesia are excluded from most development policies, there are many international–national development NGOs working to assist these communities, mostly coordinated under POKJA AMPL (Drinking Water and Sanitation Working Group) by BAPPENAS (National Development Planner Body). There are only a few groups working on the rights based approach. KRuHA does not work on the development level arguing that it is the government's role to do so. Maintaining contact with the Global Water Justice network, including sending reports/submission to the UN's agencies has proved effective in providing realities from the ground level and countering false government and corporate claims on the fulfillment or violations of the right to water and sanitation. The NGO's role is important in order to prevent government from softening/weakening reports and indicators on rights.

Describe your own background in water-related work and development.
My involvement is mostly advocacy and networking experiments rather than an academic background. I started to work with communities affected by the big palm oil plantation. I did community organizing on the east coast of Sumatra and the west coast of Java. I also learned alot of things from peasant organizations like Via Campesina. The daily problems experienced by marginalized communities have been the most valuable learning experience for me and KRuHA. We believe that the water-related problems come from political bases, rather than the lack of scientific or economical sources.

Describe the importance of improved sanitation systems for health and water safety in your country or state/province.
It is extremely important since we are at a very low water security level. Water and sanitation are still excluded from the national public health scenario.

Describe major priorities in your own work and/or NGO work you are associated with for the next five years.
First, improving the capacity and capability of citizens, engaging the newly elected government to use the right water mechanisms. Second, mitigating negative impacts from widespread extractive activities in looking for new energy sources (geothermal, fracking etc.).

Third, formulating a genuine IWRM (Integrated Water Resources Management) based on local knowledge and experience, this includes the plan to form a peasant river parliament, water user groups, finding alternative models of financing (social based environment service payment). Fourth, supporting the Finance (Tax) Justice Initiative Campaign to look for fiscal spheres for water and sanitation financing. Fifth, developing an Asian Water Justice Network for the Right to Water and Sanitation.

CHAPTER FIVE

Laos: The Poorest Country in Asia

Country Overview

Laos is a small, landlocked, poverty stricken nation with major development challenges. There are 17 provinces, one municipality and one special region, 142 districts, 10, 912 villages with 68 percent of the population living in the rural areas. In 2010, water supply in the rural areas was estimated at 52 percent, sanitation coverage at 40 percent, 72 percent water coverage in the urban areas, and 86 percent urban sanitation coverage. Malaria is a significant problem in remote, mountainous regions of the country. There is poor service and health delivery in remote parts of the country and these barriers present an ongoing development challenge. Waterborne and food-borne diseases are the most common health challenges facing the population. There is a strong correlation between waterborne and food-borne diseases. The government has designated 72 poor districts as a priority for targeted development. Accordingly, there are wide gaps between the urban and the rural water quality and access. The Lao Constitution was adopted on August 15, 1991 and amended in 2003. It has two articles that specifically address water and the environment. Article 19 states: All organizations and citizens must protect the environment and natural resources: land surfaces, underground resources, forests, animals, water sources, and the atmosphere. According to Article 25, adopted in 2003: The State attends to improving and expanding public health services to take care of the people's health. The State and society attend to building and improving disease prevention systems and providing health care to all people, creating conditions to ensure that all

people have access to health care, especially women and children, poor people, and people in remote areas, to ensure the people's good health. The State promotes private sector investment in public health services in accordance with the laws and regulations.[1] Laos is heavily dependent on freshwater from the Mekong River with 97 percent of the people getting their water needs from this important water source. The falling water levels of the Mekong, partly accelerated by climate change, are thus a major developmental, health, and economic concern. Over 50 percent of the population in the six Mekong River subbasins that include Laos have chronic water shortages. The Mekong River and its tributaries form one of the largest river systems in the world and comprise the vast MRB (Mekong River Basin), which is globally ranked as the twelfth largest river. Of the total estimated MRB population of 68 million, about 53 million live in the rural areas. In the case of Laos, the limited rural water access, water quality, and sanitation accelerates the rural health burden. Moreover, about 80 percent of the Lao population earns a livelihood through subsistence agriculture that is heavily dependent upon the Mekong River.

Major health, economic, and water indicators

Human Development Index (HDI) for Laos, 2014: 139
Population, 2014: 6.77million
Gross national income (GNI), 2012: USD 1247.00
Life expectancy, 2012: female: 69.4
male: 66.4
Improved rural water source, 2012: 65 percent
2010: 60 percent
Population percentage with access to improved sanitation, 2013: 63 percent
global average: 72 percent
Rural population, 2012: 64.6 percent
Poverty index, 2008: 27.6 percent
Homeless population, 2014: 19.7 percent
Carbon dioxide emissions per capita (tons), 2014: 0.29

Laos has significant water resources yet lacks consistent access, quality, and distribution. Being one of the poorest countries in the region and the world, this is a major challenge for the Lao government. There is little government inspection and monitoring of groundwater quality in the country. With increased urbanization and growth, water quality is vulnerable to higher rates of contamination. "Currently, there are some problems related to waste and polluted water in major urban areas

from varied community use (residential density, hotels, hospitals, and entertainment centers). In addition, there is water pollution from agricultural and industrial sectors including mineral exploitation."[2] About 20 percent of the population at the poorest socioeconomic level have the lowest access to water and sanitation. Poverty at the rural level is a chronic problem and this extends to the issue of water and sanitation. According to the Lao Ministry of Health, "Only 38.9% of all schools currently can afford water and sanitation access for students and teachers. An additional emerging issue is the need to improve the levels and quality of water and sanitation services at health facilities, particularly rural and remote health centers. Nationally identified poor communities are now primarily located in the mountainous areas of Northern and Eastern Lao PDR where access by road is limited. In addition, these communities often continue to face water access difficulties."[3] Water and sanitation coverage is improving and the country met the MDG goal 7 on water and sanitation according to the UNDP and ESCAP figures.

Vientiane: City Water Profile

Vientiane, located on the Mekong River, was established as the capital of Laos in 1563. In 2014, the total population was 825,000. Rapid urbanization and industrialization are placing strains on city services and capacity. Due to extended dry seasons and accelerated population growth, the VWSE (Vientiane Water Supply Enterprise) is facing increasing difficulties in providing a consistent water supply for all the city residents. The four main water treatment plants in the city have a combined capacity of 180,000 cubic meters daily yet city requirements are 300,000 cubic meters per day. A study on wastewater management and building in Vientiane noted that "a rapidly growing population in the urban area of Vientiane Capital City, is becoming a serious problem because of the lack of a sufficient drainage system and lack of sewerage systems, while on-site sewerage disposal or septic tanks are often poorly designed. Further contributing to the problems in urban areas is stagnant untreated wastewater from households and some small industries with open road drains, flowing directly into marsh or natural channels. This mixing of sewerage in the storm drainage system will continue to have a detrimental impact upon public health."[4] In Vientiane, approximately 72 percent of the population have access to safe drinking water. Further evidence of groundwater contamination in Vientiane is contained in a report by Baetings and O'Leary (2010),

which noted that thermo-tolerant coliforms were discovered in 31 of 33 test samples taken from locations around the city. The study observed that these findings indicated an intermediate threat to health if the water is ingested by people.

The United Nations and UN-Habitat define a slum household as a group of individuals living in the same household in an urban area who do not have one or more of the following: durable housing of a permanent nature that protects against extreme climate, adequate space for living, which is defined as no more than three people sharing the same room, obtainable and easy access to safe water in sufficient quantity at an affordable price, access to adequate sanitation in the form of a private/public toilets shared by a reasonable number of people, and security from forced eviction. It is clear that with rapid urbanization in Vientiane, the situation of slum growth and elevated poverty is more pronounced. Unsafe water, inadequate sanitation, overcrowding, competition for fixed resources, the spread of disease, increasing health problems are more evident in parts of Vientiane. According to Lao PDR–United Nations report:

> Diseases that are commonly reported amongst the urban poor include dysentery, cholera and other diarrheal diseases, typhoid, typhus, leptospirosis, malaria, dengue, hepatitis, scabies, chronic respiratory diseases and intestinal parasitic infections. Repeated illnesses in mothers and young children lead to malnutrition. Lao PDR's urban poor areas need to be given attention to prevent the development of slum areas as in other Asian cities. Recalculation of the LSIS data by the LSB shows that an estimated 20 per cent of the urban population live in a house that poses health risks. Safe water, hygiene education and sanitation, therefore, need to be prioritized.[5]

Health and Human Rights Challenges

Waterborne diseases and food-borne diseases that contribute to diarrhea, cholera, typhoid, and other illnesses are ongoing and serious health threats in Laos. Inadequate, unhealthy water supply and improper sanitation systems are major development gaps in the country. The high mortality rate and low average life expectancy (60 years) reflect a low level of overall health conditions in the country. Major infectious diseases in Lao include: food and waterborne disease, bacterial and protozoal

diarrhea, hepatitis A, and typhoid fever. Vector-borne diseases include dengue fever and malaria. The risk of infectious diseases in Lao is ranked high.[6] Malaria is the most serious public health problem although the incidence of malarial mortality has been sharply reduced in the last two decades. Malaria mortality has been reduced from 7.1 per 100,000 in 2000 to 0.3 per 100,000 in 2011. Moreover, the 2011 National Bed Net Survey reported that 98 percent of children sleep under a bed net. The malaria risk is highest along the Laos-Myanmar border in the provinces of Bokeo and Louang Namtha and along the Laos-Thai border in the provinces of Champasack and Saravan. Acute respiratory illness and diarrhea are major causes of child mortality. About 55 percent of the total population have access to safe water, and 40 percent to proper sanitation facilities. Diarrhea, cholera, hepatitis, and intestinal parasites are prevalent communicable diseases. Most of these diseases are transmitted by the fecal-oral route and are linked to poor sanitation and water quality, poor hygiene, and to inadequate water supply. Surface and ground water contamination is evident in both the rural and the urban water sources yet more pronounced in the rural areas.

There is a troubling and persistent gap between the urban-rural water/sanitation coverage and access. With 70 percent of the population living in the rural areas, development on this critical issue remains a national health and economic priority. Water and sanitation coverage is generally on the rise but more attention is needed to reach satisfactory public health targets. Lao PDR has increased household access to safe drinking water. In 2015, reducing by 50 percent the proportion without improved drinking water in the rural areas was not met, improving the proportion by 50 percent without improved drinking water in the urban areas was met, reducing by 50 percent the proportion without sanitation in the rural areas was not met while reducing the proportion by 50 percent without sanitation in the urban areas was met. Numerous studies point to the fact that unsafe water and sanitation is a major health and economic burden. "Poor sanitation and hygiene cause at least 3,000,000 disease episodes and 6000 premature deaths annually. Some 80–85% of these diarrheal cases are caused by the adverse impact of poor sanitation and hygiene via various fecal-oral transmissions, including drinking water as a route. The most vulnerable group and often the most impacted upon is children under five who account for over half of the annual deaths (3,256) per year attributed to poor sanitation and hygiene."[7]

Dug wells as a source of drinking water continue to pose a health problem to citizens. This problem is more pronounced in the rural areas.

"In 60% of the communities that were using dug wells as their source of water, frequent outbreaks of diarrhea and related diseases occurred. In comparison, the level of diarrhea and similar diseases in communities using hand-pumps or GFS (gravity fed systems), was much lower; 23% where hand-pumps were used and 16% for communities with GFS. It was also observed that water from the dug wells had a higher turbidity than recommended in the WHO guidelines which is likely due to external contamination. Seventy percent of dug wells were found to pose intermediate risks to health while twenty percent were considered high risk."[8] Contamination of dug wells is due to multiple factors including poor protection of the well, sewage leakage, poor drainage, well cracks, and decomposition and surrounding pollution.

Water Contamination: Arsenic Case Study

Laos has a recurring problem of arsenic contamination in ground water that is used as a source of drinking water. The health risk and specifically cancer threat posed by arsenic poisoning has been well documented. Arsenic is known to contaminate the water of millions of individuals around the world. The potentially devastating effects of arsenic on human health demands further investigation due to the fact that arsenic is found in high levels in many drinking water sources. Arsenic and other trace element concentrations were discovered in tube well water collected in the Lao PDR provinces of Attapeu, Bolikhamxai, Champasak, Savannakhet, Saravane, and Vientiane. "Water samples, especially from floodplain areas of central and southern Laos, were significantly contaminated not only with As, but with B, Ba, Mn, U, and Fe as well. Total As concentrations ranged from <0.5 μg L(-1) to 278 μg L(-1), with over half exceeding the WHO guideline of 10 μg L(-1). 46% of samples, notably, were dominated by As. Samples from Vientiane, further north, were all acceptable except on pH, which was below drinking water limits. Causes of elevated As concentrations in Lao tube wells were considered similar to those in other Mekong River countries, particularly Cambodia and Vietnam, where young alluvial aquifers give rise to reducing conditions."[9]

Sanitation: A Critical Health Right

The coverage of improved sanitation has increased since the mid-1990s yet considerable progress is needed. "Even if Lao PDR achieves the

MDG sanitation target of 60%, this achievement is still unsatisfactory from a public health point of view because of the large proportion of people practicing open defecation. Achieving only 60% coverage by safe sanitation will not substantially reduce this risk."[10] The economic costs associated with poor sanitation coverage and practices are significant. In 2006, Lao PDR lost an estimated LAK 1.9 trillion (USD 193 million) due to poor sanitation and hygiene, equivalent to approximately 5.6 percent of GDP (gross domestic product).[11] Improved sanitation coverage has increased threefold since the 1990s. If this trend continues, Lao PDR will achieve the MDG target of 60 percent. The urban sanitation coverage has improved markedly with a coverage rate of 88 percent. The rural coverage at 47 percent is far behind the urban levels. The urban-rural imbalances are far more pronounced in sanitation than in water coverage. According to a report by the Lao Ministry of Health and the United Nations, "In the case of sanitation, the differences between urban and remote rural families, between uneducated groups and groups with higher education, between the richest and poorest quintiles are much greater than is the case for water coverage. The sanitation coverage in urban areas is 4 times that in rural areas without road access. The most educated families have 2.5 times more sanitation access than those with no education. Sanitation coverage is 8 times better amongst the rich than amongst the poor. The sanitation coverage amongst the different ethnic groups follows the patterns set by the poverty quintiles and education. The lowland groups have the highest coverage, whilst those living in rural areas without road access show the lowest coverage. Some 38 per cent of the population still practice open defecation. The proportion is much higher amongst the poorest and least educated groups, as expected."[12]

Wastewater disposal and sewage treatment in Laos is generally inadequate and are contributing factors to chronic health problems and environmental degradation particularly with water sources. There are a number of factors that mitigate the effectiveness of sewage disposal and treatment systems including faulty construction of latrines, faulty septic tanks, leakage of septic tanks, and erosion of sewage systems. "The generation of solid waste in urban areas in Lao PDR is on the rise, and poses an emerging threat to the quality of surface and groundwater. The current annual waste generation in 2005 was estimated at 270,000 tons. Only Vientiane City and the four secondary towns have landfills, but the disposal areas are small and inadequate. Over two thirds of municipal waste could be recycled, but the current scale of recycling in Lao PDR is still very modest."[13]

Environmental Challenges

Climate Change

Lao PDR faces significant threats from climate change due to its heavy reliance on agriculture and natural resources. There is an increased likelihood of both floods and droughts with a considerable impact upon agriculture, forestry, water resources, health, and economic development. Since the country is heavily dependent upon the Mekong River and MRB, the effect of climate change upon this major waterway will be considerable. The report, *Mekong Basin Water Resources Assessment*, outlines some of the major climate-change implications in Laos by region:

Chiang Saen, which includes China, Myanmar, and Northern Laos: Temperature and annual precipitation increased, Dry season precipitation increased, Annual runoff increased, Dry season runoff increased, Annual flows into Lower Mekong Basin increased by 30 percent, No reduction in dry season flow, Potential for increased flooding;

Moung Nouy in Northern Laos: Agricultural productivity decreased, Existing food scarcity increased, Temperature and annual precipitation increased, Dry season precipitation increased, Annual runoff increased, Dry season runoff increased, Potential for increased flooding;

Luang Prabang in Northern Laos: Agricultural productivity decreased, Existing food scarcity increased, Temperature and annual precipitation increased, Dry season precipitation increased, Annual runoff increased, Dry season runoff increased, Potential for increased flooding;

Vientiane (Lao Capital): Agricultural productivity increased, Food availability in excess of demand decreased, Temperature and annual precipitation increased, Dry season precipitation increased, Annual runoff increased, Dry season runoff increased, Potential for increased flooding;

Tha Ngon in Central Laos: Agricultural productivity decreased, Existing food scarcity increased, Temperature and annual precipitation increased, Dry season precipitation decreased, Annual runoff increased, Dry season runoff decreased, Potential for increased flooding;

Nakhon Phanom in Central Laos: Agricultural productivity increased, Existing food scarcity increased through population growth, Temperature and annual precipitation increased, Dry season precipitation decreased, Annual runoff increased, Dry season runoff increased, Potential for increased flooding;

Mukdahan in Southern Laos: Agricultural productivity unaffected, Existing food scarcity increased through population growth, Temperature and annual precipitation increased, Dry season precipitation decreased, Annual runoff increased, Dry season runoff increased, Potential for increased flooding;

Ban Keng Done in Central Laos: Agricultural productivity increased, Food availability in excess of demand decreased, Temperature and annual precipitation increased, Dry season precipitation decreased, Annual runoff increased, Dry season runoff decreased, Potential for increased flooding.[14]

Due to widespread poverty and heavy agricultural dependence Laos will be affected substantially by climate change. Moreover the financial obligations incumbent upon the national government and provincial governments to minimize some of the effects of climate change and institute preventative action will be difficult to manage. Lao PDR acceded to the UNFCCC in 1995 and ratified the Kyoto Protocol in 2003. In 2008, Lao PDR established a National Steering Committee on Climate Change and a National Climate Change Office in order to guide and oversee policy commitments.

The Mekong River

The MRB has two regions: the Upper Mekong (UMRB), which includes China; and the Lower Mekong River Basin (LMRB), which includes Laos, Thailand, Cambodia, and Vietnam. The Mekong River traverses Laos, Vietnam, Cambodia, China, Myanmar, and Thailand. It is the longest river in Southeast Asia. Laos has the highest volume of the river water and highest portion of the river basin at 35 percent. Approximately 67 million people live in the MRB. The level of dependence on the MRB for agriculture, economic development, hydroelectric power, irrigation, and water is significant. By 2025, the population is projected to increase to 90 million. The falling water levels of the Mekong are a long-term phenomenon that many analysts blame on overuse and upon China due to its three large dams on the river. The effects of low water pressure are evident in many ways such as: homes and businesses in Vientiane experiencing falling water pressure and supply; ferry and cargo boats in Luang Prabang being grounded or limited due to shallow waters; and hospitals without adequate water supply.[15]

According to a study on the Mekong Basin, annual flood volumes will increase. "The frequency of 'extreme wet' flood events is likely

to increase from an annual probability of 5% under historic conditions to a 76% probability under the future climate. The indicative area of flooding in the delta is likely to increase by an annual average of 3800km."[16] At least 75 percent of the MRB population, primarily rural, depend upon the river for agriculture and fishing. Over 95 percent of the land area of Laos is dependent on the MRB to meet vital water needs. Laos is therefore highly vulnerable to any changes in MRB water flows, climate conditions, pollution, and economic sustainability. Environmental scientists have ascertained a number of tangible threats to the MRB that affect Laos, namely floods, drought, irregular water flows, pollution, and climate change.

Government Water Policy and Laws

The Lao government's Water and Resource Law is comprehensive. Major articles include:

Article 1—The Role of the Water and Water Resources Law. The Water and Water Resources Law provides principles and regulations governing the management, exploitation, development, and use of water and water resources within Lao PDR; with the aim to protect and sustain water resources and water particularly with regard to the assurance of water in sufficient quantity and of sufficient quality to satisfy the national needs in terms of domestic, agricultural, industrial uses, and the uses of other sectors in such manner as to protect the natural environment.

Article 2—Water and Water Resource. For the purpose of this Act, Water is defined as the natural liquid substance which is the basic element of water resources. Water resources are natural resources, living and nonliving, which are in the water and include aquatic weeds, sand, gravel, fish, minerals, and so forth.

Article 3—Water Sources and Basins. A water source occurs when water is collected or stored, or where there is a natural movement, either permanent or temporary. Water sources may be on the ground surface, underground, or in the atmosphere. Surface water is a water source on the ground surface in a continuous line or at a specific location, such as rivers, streams, swamps, reservoirs, or ponds. Underground water is the water source located under the ground in strata, in layers, in bulk, or mixed with the soil. Atmospheric water is the water source located in the atmosphere as cloud, rain, snow, and

fog. A river basin is the land and forest from the upstream reach of the river to the effluent of that river where all rain water falling within its boundary will tend to flow toward the effluent of the river, as a water resource system.

Article 4—Ownership of Water Resource and Water. Water resources and water are the property of the people of Lao PDR as a whole. The government acts on behalf of the people to manage and to evenly and equitably share the uses of the water. Individuals and organizations will have the right to use the water for specific purposes only when authorization is given by the concerned authority, except for use of a minor nature, as indicated in this Law hereafter.

Article 5—Promotion, Development, and Protection of Water and Water Resources. The government promotes the exploitation, use, preservation, and protection of water and water resources, and the control of related harmful effects.

Article 6—Basic Principles in Water and Water Resource Management and Use. Water and Water Resource management and use must follow the principals of national planning, and the planning cycle, as set out in Article 22 of this Law.

Article 7—Duty to Preserve Water and Water Resource. In order to preserve and to use water and water resources in the most effective way, individuals, organizations and communities have a responsibility to strictly obey the water and water resources management and use regulations.

Article 30—Water and Water Resource Protected Zones. The government will determine water and water resources protected zones to ensure adequate supplies of water of sufficient quality to serve the drinking and domestic needs of people in both the urban and the rural areas. Protected zones shall be delineated with boundary fencing. No development such as building, agriculture, industry, extraction of rock, sand, or minerals, nor cemeteries will be allowed within the protected zone. The discharge of wastewater and the dumping of garbage, chemicals, mine tailings, or any harmful material will not be allowed within the protected zone. In the event that the quality and quantity of water available for human consumption is threatened, the government will extend the area of the protected zone and add additional protective measures.

With water security and climate change posing significant issues for the Lao PDR, the government has adopted a series of important laws and initiatives. Although by no means complete, for the final arbiter of

success and effectiveness is enforcement, these steps do represent constructive progress. Major policies include:

2000 A National Water Resource Policy
2001 Law on Water and Water Resources
2010 Nam Ngum River Basin Committee (NNRBC) established. It is the first such committee of its kind in Laos and will serve as a template for other River Basin Committees.
2010 NSEDP addressing Irrigation
2010 National Water Resources Strategy and Action Plan (2011–2015)
2010 National Rural WaSH Plan of Action accepted by the LAO PDR Government for the 2011–2015 period and implemented
2011–2015 National Plan of Action Major Targets: By 2015 to have hand washing with soap practiced by 50 percent of the rural population; by 2015, 1000 rural primary schools have their WaSH facilities improved and increase coverage from 30 percent to 50 percent; by 2015, 200 rural health centers have their WaSH facilities improved; by 2015, the rural water facilities have a functionality rate of 75 percent compared to 50 percent in 2010; by 2015, access to improved rural water supplies has been increased by 24 percent to 75 percent as compared to 51 percent in 2008.

Water Development Project Profile

Water Supply and Development Project in Pakse City, Champasack Province, Lao PDR

Lao PDR is rich in water resources. The population is just over 6 million. Total average annual available surface water resources in Lao PDR are 272 cubic kilometers, which is equivalent to more than 55,000 cubic meters on an annual per capita basis and ranked as highest in Asia. A small percent of the available water resource has thus far been developed. Domestic water supply and sanitation are important target areas for socioeconomic development.

Improvement Objectives

i. Review domestic water supply policy and strategy in medium and long term;
ii. Assess progresses made by sector, comparing to the set strategic targets;

iii. Study a case as a reference for better understanding of the situation of the domestic water supply sector of the country.

Policy and strategy in the medium and long term: National Strategy for Rural Water Supply and Environmental Health Sector (June 2004).

The government goal: To achieve 90 percent access to improved water supply in both the urban and the rural areas.

Millennium development goal in 2015: Ensure that 80 percent of the total population and 70 percent of the urban population have sustainable access to an improved water source.

Progress

To achieve these goals the urban water supply sector represented by the WSRO (Water Supply Regulatory Office), MPWC (Ministry of Public Works and Construction), set up their development plan in 2005. The goal was to install 139 water pipe supply systems in the rural areas throughout the country.

By July 2006, in the district urban areas, 51 projects (37 percent) were completed, 11 projects (8 percent) were agreed to be finalized, and 77 projects (55 percent) were left pending until financial support and development were secured.

The urban water supply schemes are mostly owned by the government through its Water Supply State Enterprises.

A small proportion of private sector investment in this sector exists. This initiative is critically promoted by the MPWC, in relying on the Government policy on privatization and investment promotion.

Challenges

The existing pipe water supply systems have been faced with low cost-recovery, which disqualifies their system operation and maintenance and customer services.

In competing with high population growth rate of 2.3 percent, the urban water supply sector has strategically been struggling and playing its effort to achieve its medium and long-term targets.

Case Study: Pakse Water Supply Development Project, Champasack Province

The City of Pakse is located along the banks of the Mekong River and Xedone River.

Pakse population: 82 thousand inhabitants (2005), accounted for 13.5 percent of total population of Champasack Province. There is only one urban water supply system in Champasak Province, located at Pakse District, while some other districts use community water supply systems.

The Pakse Water Supply System: Storage capacity of 15,000 cubic meters, Supply capacity of 3,750,012 cubic meters per year. Composed of two storage tanks with the respective capacity of 250 cubic meters and 500 cubic meters and a distribution tank sized 1,000 cubic meters.

Major Issues: This scheme served only some parts of Pakse City, covering about 85.5 percent of the townspeople in 2005. It is composed of 45 villages, 9,048 households, and 54, 797 people.

Due to insufficient water production and pipeline expansion, many people in the northward and southward areas of the town have suffered from a town-wide water shortage.

According to the Census in 1995, population of Champasack province has been steadily growing at a rate of 2.6 percent in the past, which is a high ratio compared to the 2.3 percent population growth rate of the whole county. The continuing growth of the population in the city causes low pressure in the water supply system.

Response: The Champasack Provincial Public Work and Transportation Division is exercising a major role to provide basic water services and improvements. The use of water tariffs in the city have reached high levels and the use of credit has not always been feasible.

(Source: Souphasay Komany, Head of Water Policy and Legislation, Department of Water Resources, Water Resources and Environment Administration, Prime Minister's Office, Lao PDR.)

Asian Development Bank Water Development Project, Completed in 2014

An Asian Development Bank project has been designed to improve the quality of life of the residents of small towns in Lao PDR and to enhance the towns' roles as economic, market, manufacturing, and service centers for their surrounding rural areas. It will contribute to the government's efforts to increase the percentage of the urban population with access to safe piped water to 80 percent by 2020. The project aims to strengthen the overall water supply sector by supporting the establishment of the WSRC (Water Supply Regulatory Committee);

assisting its secretariat, the WASA (Water Supply Authority), to carry out its sector regulatory functions; and helping the water supply utilities (PNPs) to become corporate entities under the Enterprise Law. The project will provide support for business and financial management, and efficient operation and maintenance to improve PNP's organizational performance and sustainability.

The project will support the provision of piped water and sanitation services for an estimated 137,000 residents in 124 villages in 15 small towns. It is a sector investment project with the following outputs: (i) a stronger and more sustainable urban water supply sector; (ii) new and rehabilitated water supply systems in 15 small towns; (iii) improved drainage and public sanitation; (iv) enhanced community action and participation; (v) more gender equity in the urban water and sanitation; and (vi) improved capacity for project implementation and operation and maintenance.

Rationale: Lao PDR remains essentially a rural country. It had a population of 5.6 million in 2005, but its high population growth rate of 2.1 percent per annum means this is expected to rise to 7.3 million by 2020. About 27 percent of the population lives in the urban centers or towns. The urban district centers and villages with populations from 2,000 to 20,000 people are classified as small towns. Inadequate water supply and poor environmental conditions in these small towns result in poor health, lost work, and school days, and more household expenditure on health care. It also deters socioeconomic development and restricts the ability of these towns to serve as key administrative and economic centers. In 2006, the overall piped water coverage in the towns was 21 percent, while sanitation coverage in the form of pour-flush toilets was 69 percent. Many urban households lack water during the dry season to clean toilet facilities, which makes it difficult to maintain hygiene in the home. The importance of water supply and sanitation services in small towns is increasing, as the Lao PDR becomes more regionally connected by better road networks, increased tourism, and greater interregional trade. Small towns located in key transport and economic corridors are instrumental in supporting the economic and human development opportunities in the surrounding rural areas.

Impact and Outcome: The impact of the project is to contribute to the government's efforts to expand access to safe piped water for 80 percent of the urban population by 2020. It will contribute to the achievement of a countrywide target of increasing safe piped water supply coverage to 65 percent of the overall urban population and providing pour-flush

latrines to 80 percent of the urban households by 2014. The outcome of the Project will be to improve the access, quality, and reliability of the water supply and sanitation services for an estimated 137,000 residents in 124 core villages in 15 small towns throughout Lao PDR. The investment cost of the project is USD 31.4 million.

(Source: Asian Development Bank)

Interview with Thinley Dorji, WaSH Technical Advisor, Laos

Thinley Dorji is a WaSH (Water and Sanitation Hygiene) specialist from Bhutan and currently based in Vientiane, Laos. He has more than 15 years of WaSH and rural development experience in Asia. Currently he is working as the WaSH technical advisor with World Vision International in Laos. Prior to that he was overseeing the National WaSH Program of Save the Children in Laos and also worked with Plan International, Laos, as the interim WaSH program manager. While in Bhutan he worked for more than nine years with SNV-Netherlands Development Organization and he also started and managed a local consulting firm, which was responsible for successfully implementing the RSAHP (Rural Sanitation and Hygiene Program) in Bhutan.

Describe the current water situation in your country in terms of health, access, and scarcity.

The Lao PDR (People's Democratic Republic) is a small, landlocked nation in Southeast Asia with a population of almost 7 million. Lao PDR is ranked 138 out of 187 countries in the 2013 human development index and is one of the poorest countries in South East Asia. Since gaining independence in 1975, the government of Lao PDR has worked to heal the country from the wounds of war and improve living conditions for all Lao people. For the past 20 years, Lao PDR has been steadily moving away from a centrally planned system toward a market-oriented economy that has led to significant progress in key social and economic indicators. Still, many challenges remain in the effort to eradicate poverty from Lao PDR. Around 80 percent of the population still depends on agriculture for their livelihoods and at least 30 percent of the population is estimated to live in poverty. Lao PDR has the most water resources of any Asian country per capita. Many of the rivers in Laos including the mighty Mekong are being dammed

to harness hydroelectricity. However, much of it is unsafe for drinking. Drinking water can be contaminated with harmful chemicals and human waste, causing a variety of health issues. Many donor organizations and international NGOs work with the government of Lao PDR to help ensure children and families in homes and schools have access to clean water and sanitation facilities.

What are the major waterborne diseases in your country and/or region where you operate?
Diarrheal diseases are responsible for one-third of all undernutrition cases and one-tenth of deaths among Lao children under the age of five. Therefore diarrheal diseases are the major waterborne diseases in Laos. However diarrheal diseases are not only associated with water, but also with the sanitation and hygiene practice, which are both very poor especially in rural Laos. Besides this there are seasonal outbreaks of cholera, typhoid, and the like.

What are the significant barriers to water health and access?
Lack of community ownership is one major issue in Laos. Many development NGOs including the government department responsible for water supply and sanitation continue to provide heavy subsidies especially the materials for toilets at the individual household level. Water supply schemes are also constructed with not much involvement of the beneficiary communities in terms of planning and the operation and maintenance. In most cases the beneficiary's communities are involved in manual labor contribution during the construction phase. In that way there are many water supply schemes that are not functioning within the first few years of operation. Maintenance committees are put in place in some cases and even training around operation and maintenance, maintenance funds, financial management of funds and the like are provided to the committee members. However different NGOs use different methodology for this and there is no systematic way of doing this. There is a lack of proper sector coordination and it is a long way from perfect. Provincial governments and also at times the district government have a MoU (memorandum of understanding) to work in the WaSH sector with many NGOs and carry on doing what they think would increase access within their province or district. This however is not necessarily coordinated well at the national level. Technology and the quality of construction at times is also not very adequate and many implementers are complacent. This definitely affects the long

term sustainability aspect of the water supply scheme. There is also a lack of a proper water safety plan/water quality testing. It is carried out randomly by different organizations involved in the sector in whatever way they can but not necessarily following one set regulation. There are government regulations around water safety standards but how they are actually followed and implemented is a big question.

What policies is the national government developing or conducting to expand water/sanitation health and access?

There are many types of water systems in Laos, namely, gravity fed systems, gravity flow system, tube well (deep borehole), dug well (shallow wells with rings), pipe scheme (water supply system with an elevated tank), rain water jar and tank.

Rural water supply technologies in the Lao PDR Program achievements by 2009 include: gravity flow system about 2,612 schemes; deep borehole 11,462 boreholes; dug wells with concrete rings about 3,624 units; rain water jars about 6,262 units; water supply with elevated tank 36 schemes; improved spring water source 40 sources; about 20 percent of programme achievements have broken down and cannot be repaired, about 30 percent of program achievements had small breakdowns and water sources were not in use during the dry season (they can be repaired and still used).

Water Supply Coverage

Water supply coverage until 2009 (data collected from 17 provinces): 21 percent coverage remains to be completed. 79 percent coverage completed as of 2009. Water supply in 2009 in both (urban and rural) was approximately 58 percent; and 52 percent in the rural areas. Community sanitation (urban and rural) about 55 percent (2009); community sanitation in the rural areas about 40 percent. Water and sanitation in schools was approximately 28 percent (2009).

Deep wells are generally uncontaminated (Fecal coliform). Dug wells are generally contaminated. Rain water is usually uncontaminated. GFS are contaminated in some schemes. Maximum iron content of ground water 10 mg/l. Maximum fluoride content 150 mg/l. High arsenic content in some small areas of the southern provinces maximum 0.1 mg/l.

Provincial analysis of water coverage and facilities based upon a water quality analysis for all provinces in 2006: A total of 17 provinces, 156 districts, 2,143 villages, 26 health care centers, 26 hospitals, 139 schools, 1,653 boreholes, and 62 dug wells.

Operation and Maintenance of Rural Water Supply
in Lao PDR–Village Agreements
Stakeholders groups and officials involved in village water improvement agreements: (1) district governor; (2) chief of the district health office; (3) village chief; (4) chief of the provincial water supply office; (5) director of the provincial health department.

Community participation included the following steps: (1) Project planning, design, and selection of water supply source; (2) Stage of construction work. Preparation of the construction work area, support to workers, contribution labor, materials, and cash; (3) Project sustainability, organization of village committee, organization of village caretakers and financial officer, collection of water fees, proper O and M (Operations and Management), proper sanitation and hygiene practices, protection of surrounding water source areas; (4) A village water committee (WATSAN committee). The main function for a WATSAN Committee is defined as: Clean and maintain the water supply system; supervise and advise on use and maintenance of taps, hand pumps and the like; collect water fees and keep accounting; organize meetings and discussions to solve problems related to water use; distribute work responsibilities among men and women; make small repairs; monitor and promote sanitation and hygiene; control waste into water sources; prevent contamination of the environment; make the monthly and yearly reports about O and M and finance.

Examples of Repair and Replacement of Water Supply Systems
Minor repairs and replacements have to be made as soon as possible when the water supply has broken. Common repairs include: Repair tools; replacement of new hand pumps; repair tools and spare parts; hand pump repair and maintenance; repair of foundation and drainage; repair of fence and roofing; drainage and platform cleaning; weekly pump cleaning and maintenance.

Obstacles to Effective Village Water Quality and Systems Maintenance
O and M skill of village water committee chief, technical skill of caretakers; no incentive for WATSAN committee; villagers/beneficiaries not willing to pay the water user fee; no transparency in the use of the water collection fee; no communities contribution in preliminary water supply system selection, planning, design, construction works; quality of project construction; attitude of caretakers; migration of WATSAN committee members; water quality problems; no regular supervision,

monitoring, and inspection by water supply district and province; no regulation for water use and received water source management.

Describe particular challenges facing vulnerable children and minority children with respect to water access and health.
More than half of Lao PDR's primary schools (especially in the rural areas) do not have both a functional water supply and toilet facilities. Access to improved water and sanitation in schools influences rates of enrolment, attendance, retention, and learning achievement, particularly affecting girls and those living in the rural areas, where school facilities are often poor.

What environmental problems are impacting water quality?
Although Lao PDR is rich in natural ground, surface, and rainwater sources, climate change has begun to affect seasonal patterns. The impact of this is difficult to predict and constitutes a contributing factor in the increasing seasonality of water sources. In addition, deforestation and transition to poorly planned and planted plantations is continuing to reduce the sustainability of water catchments, and, mining activities and the increasing use of chemicals in agriculture is also posing a serious risk. These factors and recent outbreaks of WaSH-related diseases point to the need for new guidelines and improved standards, better regulation and control of water quality, the formulation of village water safety plans, and increasing cooperation with the water resources and environment administration. Moreover, the presence of unexploded ordnance (UXO) across large parts of the country poses a risk to developing water and sanitation infrastructure and transporting construction materials to communities. Many ethnic groups in Laos depend on shifting cultivation of upland rice for their living. This has a huge impact on the deterioration of the water catchment areas since large areas are burnt and cleared every year for cultivation. This has also resulted in the drying up of water sources that previously had abundant supply.

CHAPTER SIX

People's Republic of China: Confronting Catastrophic Drought and Pollution

Country Overview

China is the most populous country in the world and is burdened by substantial poverty and income inequity. There are 100 million economic migrants in China. The country is vulnerable to both drought in the north and flooding in the south. Moreover, China, which has 20 percent of the global population, has only 7 percent of global water resources. Survey data from the WHO (World Health Organization) and UNICEF Joint Monitoring Program for Water and Sanitation note that over 90 million Chinese do not have access to an improved water source and 450 million citizens do not have access to improved sanitation. These are major development problems which severely impact health, development, and water quality. Increasing water shortages in the north, where approximately 64 percent of the population live, pose significant human rights, environmental, and economic crises for China. Between 1978 and 2010, 600 million Chinese were lifted out of poverty.[1] Although China has achieved rapid advances in elevating citizens out of extreme poverty and the many forms of deprivation that go along with it, the sheer size of the Chinese population that continues to live in socioeconomic distress impedes overall progress on a range of important issues including water security and health. Approximately 55 percent of the population is rural. Poverty rates are typically higher in the rural settings compared to the urban areas. Urban China has 95 percent access to piped water while the rural rate is 45 percent.[2] Moreover, approximately 60 percent of China's 661 cities

continue to endure water shortages. "With a population of 1.3 billion, China recently became the second largest economy and is increasingly playing an important and influential role in the global economy. Yet China remains a developing country. Official data shows that about 98.99 million people still lived below the national poverty line of RMB 2,300 per year at the end of 2012. With the second largest number of poor in the world after India, poverty reduction remains a fundamental challenge."[3]

Major health, economic, and water indicators

Human Development Index (HDI) for China, 2014 : 91
Population, 2014: 1.385 billion
Gross national income (GNI), 2012: USD 5535.00
Life expectancy, 2012: female: 75.8
male: 72.1
Improved rural water source, 2012: 85 percent
2005: 78 percent
Population percentage with access to improved sanitation, 2013: 64 percent
global average: 72 percent
Rural population, 2012: 48.1 percent
Poverty index, 1998: 4.6 percent
Homeless population, 2014: 4.48 percent
Carbon dioxide emissions per capita (tons), 2014: 6.19

China is divided into four major climactic zones. "The arid zone is situated primarily in the inland river basins in the west and northwest. The semi-arid zone is in the upper and middle areas of the Huang (Yellow) river basin in central China. The semi-humid zone experiences both flooding and droughts. The NE (North East) subzone consists of the Songhua-Liao river basin in the northeast of the country. The HHH (Huang-Huai-Hai) subzone includes the North China plain. The humid zone is located in the south and southwest. The mid-lower Yangtze subzone has a subtropical climate. The Zhu-Min subzone comprises the Zhu (Pearl) and southeast river basins. It has a tropical monsoon climate that allows year-round cropping. The mountainous South West subzone has a mixed tropical/subtropical climate."[4]

Due to the vast and diverse landscape of China, climate and water variations can be extreme. The major river basins include the Song-Liao, Huai, Huang (Yellow), and Hai-Luan in the north and the Chang (Yangtze) and Zhu (Pearl) in the south. Although groundwater resources are abundant in China, chronic problems of pollution, infrastructure

weakness and poverty often inhibit access to safe water sources for millions of Chinese. "About 70 percent of the groundwater resources are in southern China and 30 percent in northern China. The aquifers vary greatly across northern China and are geologically complicated. Unlike the south, where villages in mountainous areas can tap groundwater resources, mountainous areas in northern China are often groundwater deficient. In some areas, especially in the eastern parts of the Hai river Basin, there is a naturally occurring saline layer."[5]

In China, the dual problems of water shortage and water pollution are becoming more severe in many parts of the country. China has been experiencing increasing levels of water scarcity and stress for several decades and population growth is contributing to the problem. "In normal water years among 662 cities, 300 will have insufficient water supplies and 110 will experience severe water shortages, 30 out of 32 metropolitan areas with populations of more than 1 million people struggle to meet water demands."[6] At current water supply levels, total water shortage is estimated to be 30–40 billion cubic meters per year and is even larger in dry years.[7] According to projections, by the year 2050, China's water deficit could reach 400 billion cubic meters.[8] As China develops and water demand surges, the need for water sources for human use, agriculture, and industry will be strong. Another serious dimension to China's water security problem is climate change which will impact the country with detrimental effect. Flooding, drought, rising rainfall, food shortages, lowland area flooding, climate change related illness and disease are all symptomatic of climate change and issues that the central government and regional governments must increasingly confront.

Shanghai: City Water Profile

Shanghai is a coastal metropolis and the fifth largest city by population in the world at 24.5 million. It rests on a flat alluvial plain with a low sea level base. The land area is 6,340.5 square kilometers comprising 18 districts. The city is situated on the southeastern frontier of the Yangtze River Delta. The water table along Shanghai's coast is quite low at 80–120 cm below the surface. The surface water for the city is generally quite polluted. "The main section of the Huangpu River that travels through the city proper is undoubtedly the most polluted section designated class 3 to 5, depending on the location of the measuring devices. In general, water quality declines in the Huangpu as it enters the Shanghai city proper. The upper reaches of the Huangpu River,

while in general of a higher quality than the main section of the river, are also highly polluted. Dianshan Lake, Taipu River are in Class 3, while Yuanxiejiang is Class 4 and Damaogang is Class 5."[9] A class four designation means levels that are suitable for industrial use only. Many of the tributaries of the Huangpu River contain high pollution levels. The quality of Suzhou Creek is very contaminated particularly where it joins the Huangpu: "it is highly toxic and has minimal oxygen available, with bubbles of gases along its entire course."[10] "In reaction to rapid subsidence at 3 mm a year, the government pumped surface water into the aquifers. This action contaminated the aquifers with polluted surface waters and once contaminated aquifers are extremely difficult to clean"[11] "Rain water quality in Shanghai is plagued by problems resulting from high ambient concentrations of sulphur dioxide in the air. High SO_2 and suspended particulate levels stem from Shanghai's reliance on coal-burning. The SO_2 in Shanghai creates a chronic smog known as the Yellow Dragon and rain that is so acidic that it burns holes through nylon shirts."[12]

Climate change poses a major threat to the city of Shanghai. Due to its low sea level positioning and historic flooding in the region, the impact of climate change is expected to be considerable. The highest point is the peak of Dajinshan Island at 103m and the average elevation is only 4m. According to a recent study, "Shanghai is particularly vulnerable to flooding because it is exposed to powerful storm surges and the land subsides as sea levels rise. Also, the city is poorly prepared, with little resilience to a major flood and insufficient flood shelters for victims. Climate scientists predict that extreme weather events brought by climate change, such as larger storms and heavier rainfall, will increase the prospect of floods in many areas."[13]

Shanghai is ranked as having among the most polluted water sources among major world cities. Major pollutants consist of bacteria including raw sewage, chlorine, lead, and toxic heavy metals. In recent years authorities have relied upon chlorine to clean water from impurities and contamination from sources such as sewage. However, the high use of chlorine carries severe health risks to the population consuming the chlorine saturated water. Approximately 80 percent of Shanghai water is derived from the Huangpu River and the remaining 20 percent comes from the Yangtze River. Both of these rivers are highly polluted and do not meet safe drinking water standards. The Shanghai Environmental Protection Bureau has ranked the water of the Huangpu River suitable only for industrial use. A 2005 report by the Yangtze River Water Resources Commission stated that about 30 billion tons, including at

least 9 billion tons of domestic sewage, had been dumped into the river.[14] Since then, the level of dumping has continued to be unacceptable for health standards and environmental sustainability. Shanghai tap water has been found to contain traces of giardia, cryptosporidium, chlorine and chlorine byproducts, nitrites and nitrates such as pesticides, heavy metals including lead, mercury, aluminum, cadmium, chromium, and copper. The use of chlorine by the Chinese authorities to eliminate biological and microbial elements thus "decontaminating" the water is a short term and potentially dangerous solution. Numerous studies indicate that the consumption of chlorine in drinking water sources is correlated with increased cancer risks. The American Journal of Public Health has reported evidence that associates chlorine to increases in certain types of cancer, asthma, and skin irritations. Data suggest that exposure to chlorination by-products in drinking water is associated with an increased risk of colon cancer.[15] Shanghai is confronted with the serious problem that nearly all surface water is polluted. Moreover, water diversion from the Yangtze River to support the parched north caries the risk of high salinity in return water flows if they are too low. According to the Water Resources Protection Bureau in Shanghai, the current capacity of the city's water supply is about 16,000 cubic meters per day, which is able to cover the demand of 26 million people. Yet, once the population reaches 30 million, the demand would rise to 18 million tons per day, exceeding the current capacity. The population of Shanghai is projected to reach 30 million by 2030. Clearly, Shanghai authorities must address a series of challenging and protracted issues in the near future related to climate change, elevated pollution levels of air and water, population pressure, flooding, and the increased salinity of water sources. These challenges confront public officials with the demanding task of securing a better balance between environmental concerns and industrial-economic growth.

Health and Human Rights Challenges

In 2012, approximately 470 million people lacked access to improved sanitation and 400 million to household piped water. "The risk of infectious disease in China is ranked as intermediate. Food and waterborne diseases include bacterial, hepatitis A and typhoid fever. Vector borne diseases include Japanese encephalitis."[16] China has significant problems related to water pollution, waterborne diseases, and water scarcity which are exacerbated in the rural areas. Moreover, the growing

incidence of cancer-related illness and fatality due to contaminated water is an alarming health and environmental crisis. Regional examples of severe water and soil contamination are extensive. The *Nanfang Daily*, in Guangdong province in 2008, reported that 12.62 billion tons of polluted materials and 8.3 tons of wastewater were dumped into water sources in and around Guangdong. There are numerous diseases related to contaminated water and inadequate sanitation. These problems are magnified at the rural level where poverty and water contamination levels are notably higher compared to the urban settings. According to the WHO, 88 percent of diarrhoeal disease is attributed to unsafe water supply and inadequate sanitation and hygiene. A water-related health study on China noted that

> unsafe water and poor sanitation and hygiene accounted for 62,800 deaths and 2.81 million DALYs (disability-adjusted life year (DALY) is a health metric that accounts for years of life lost from early death or from disease and disability) in China in 2008. Most (83%) of the attributable disease burden and most (97%) of the deaths occurred in young children. Diarrheal disease accounted for 98% of the attributable DALYs. If all provinces attained universal coverage with improved water and sanitation, an estimated 1.84 million DALYs and 42,000 deaths from diarrhea alone could be prevented annually. We found unsafe water and poor sanitation and hygiene to be particularly detrimental to the health of young children, as they account for 61,200 deaths and 2.33 million DALYs in children under five, predominantly attributable to diarrheal diseases. Geographically, the disease burden attributable to unsafe water and poor sanitation and hygiene is concentrated in China's poorest, inland provinces.[17]

The link between waterborne disease, contaminated water, and inadequate sanitation systems is well established in the medical literature. Inorganic pollution is a chronic health threat to the population. Although most Chinese citizens boil their drinking water, inorganic pollutants are unaffected. Hence, about 70 million Chinese are drinking contaminated groundwater leading to diseases such as chronic arsenic and fluoride poisoning.[18] Repeated exposure to toxic drinking water in China has been associated with rising rates of chronic diseases including stomach and liver cancers. Chen Zhizhou, a cancer specialist at a research institute affiliate of the Chinese Academy of Medical Sciences, observed that "the main reason behind the rising number

of cancer cases is that pollution of the environment, water and air is getting worse by the day."[19] Liver and stomach cancers are the leading causes of cancer mortality in rural China. Many studies in China and abroad have shown a strong association between drinking water pollution and cancer incidence and mortality. A study conducted in Lujiang County, Anhui province, sought answers for the increasing rates of pollution-related cancer. The authors found that rising mortality rates for stomach and liver cancers were associated with high levels of inorganic compounds in the local surface water bodies. [20]

In many urban and rural settings, the dumping of raw sewage and toxic chemicals into waterways and drinking water sources is rampant. As the linkage between environmental quality and health become more apparent and scientifically documented, the alarming extent of pollution confronts China with the urgency of costly yet necessary corrective and preventative solutions. Moreover, water pollution and the adverse health effects pose not only a dramatic health burden on the country but an economic one as well. At the request of the Chinese government, the World Bank initiated a major study to determine the cost of water and air pollution upon the economy. The combined health and non-health costs of outdoor air and water pollution was calculated at approximately USD 100 billion a year or about 5.8 percent of the country's GDP.[21] According to one study,

> Chinese cities have limited facilities or infrastructure to treat sewage or drinking water, which mostly comes from surface water of large rivers or lakes. More than 300 of China's 640 cities face water shortages, with a total annual scarcity of nearly 6 billion m^3. Most cities and communities simply discharge untreated wastewater and sewage produced by households and industries into surrounding surface waters, including rivers, lakes, and coastal areas. In a number of studies, pollutants released by TVIEs (Township–Village Industrial Enterprises) have been linked to adverse health effects. In China overall, liver and stomach cancer deaths have doubled since the 1970s, and are now the leading causes of cancer mortality in rural China. China had the highest liver cancer death rate in the world.[22]

Cancer rates in China have reached high per capita levels due to a number of factors though many health experts suggest that chronic levels of water and air pollution are powerful contributing factors. According to the WHO, "about 50% of new liver and esophagus cancer

cases worldwide were recorded in China, 51% of global deaths from liver cancer and 49% of global deaths from esophagus cancer occurred in the country. China also saw more than 40% of global newly diagnosed stomach cancers and related deaths in 2012."[23]

Biological and chemical contaminants are the two major groupings of water pollutants. Biological pollution is composed of microorganisms causing infectious hepatitis A or E, dysentery, typhoid fever, cholera, and diarrhea. Chemical pollution is composed of hundreds of elements. The main elements found in water include arsenic, chlorine, nitrates, phosphates, mercury, chrome, fluorine, and lead. Diarrhea is a major source of illness and a leading cause of death for children under the age of five. Chronic diarrhea leads to a weakening of the body and exposure to secondary infections and illnesses. Chemical pollution can lead to acute poisoning. In the case of arsenic, which is a naturally occurring geologic phenomenon, poisoning and long- term exposure generally does not become symptomatic for 10–15 years by which time substantial bodily damage has occurred. Arsenic poisoning is also difficult to detect by medical authorities without sophisticated diagnostic equipment which is not normally available in poor rural communities. In rural China, an estimated 300 million people drink contaminated water daily.[24] Moreover, 63 million people in China consume water with high concentrations of fluorine. "The 1984 issue of Clinical Toxicology of Commercial Products lists fluoride as more poisonous than lead and just slightly less poisonous than arsenic; causing dramatically premature and fatal ageing of the whole body and cancer."[25] The dual problems of contaminated water and water scarcity will lead to a crisis for China or conversely, new opportunities for effective water management systems and sustainable environmental practices at both the rural and the urban level. China's freshwater resources have a limited capacity and face escalating demand pressure. Another major complication is the fact that underground aquifers and water tables are dropping. Simply stated, there is not enough water to support the current population (2015) of 1.41 billion let alone the projected population of 1.46 billion by the year 2050.

China: The Rise of Cancer Villages

In recent years, a new and critical health emergency derived from years of toxic pollution in water ways and soil has emerged to cause health devastation in China. The Chinese government has acknowledged the existence of at least 450 "cancer villages" some with cancer rates up to

30 times higher than the national average. Data and studies in China confirm the prevalence of high rates of chemical and bacterial pollution that is exposing hundreds of millions of Chinese citizens to severe health risks and a growing cancer epidemic. In 2014, the estimated number of new cancer diagnoses was three million and two million cancer fatalities. The top five cancers diagnosed were lung, breast, stomach, liver, and esophagus. Epidemiological estimates conclude that chronic infection is the main risk factor for cancer in China, accounting for 29 percent of cancer deaths.[26] Waterborne disease is a term utilized to describe infections that are mostly transmitted by contact with infected water and/or food. Protozoal infections, parasitic infections, bacterial infections, and viral infections can all be spread through contaminated water. Evidence increasingly mounts that the high rate of waterborne diseases in the country is correlated with high cancer rates.

As noted, arsenic (As) found in surface water sources is a naturally occurring geologic phenomenon. High levels of arsenic in surface waters have been detected for years in ground waters of many regions of China. These regions include: the plain of the Great Bend of the Yellow River, the Hu-Bao Plain in the Inner Mongolia Autonomous Region, the Datong basin of Shanxi province, the floodplain of the northern side of the Tian Mountain of Xinjiang Uygur Autonomous Region, and the southwest coastal plain of Taiwan.[27] High levels of As in drinking water is linked to skin cancer and other cancers, hypertension, and vascular diseases. According to the Ministry of Water Resources in 2005, 63 million people drink water with high concentrations of fluorine. Fluorides are compounds that are composed of the element fluorine and other substances, often a metal. Sodium fluoride, stannous fluoride, and fluoride monofluorophosphate are examples of fluorine. Fluorides are absorbed into the bloodstream through the digestive track thus easily consumed with affected drinking water.

In China, mortality rates from liver and stomach cancer, in particular, exceed the global average. Liver cancer is the most prevalent form of cancer in rural China. There are many scientific studies specific to China that have addressed the linkage between contaminated drinking water and cancer. Su Delong (1980) explored causal factors of liver cancer in Qidong county of Jiangsu province, and noted that the morbidity of liver cancer was closely related to drinking water contamination.[28] Xu Houquan et al. (1995) conducted a case-control study of risk factors of liver cancer around the Nansi Lake, Shandong province. They demonstrated that drinking lake water, contact with lake water, drinking alcohol, and eating fish were all notable risk factors for liver cancer. The

estimated odds ratios were 6.55, 3.24, 1.86, and 2.55, respectively.[29] Xu Houquan et al. (1994) conducted a retrospective cohort study on the relationship between water pollution and tumors and calculated that the mortality rates of stomach, esophagus, and liver cancer for people drinking lake water were higher than those drinking well water. The RR (relative risks) were 1.56, 1.50, and 1.63.[30] The large-scale national analysis on organic pollution of drinking water and liver cancer by Wang Qian et al. (1992) revealed that mortality from liver cancer for men and women was positively associated with the COD (chemical oxygen demand) in drinking water.[31] In a comprehensive 16 year retrospective cohort study in an area with elevated stomach cancer rates, Wang Zhiqiang et al. (1997) determined that mortality from stomach cancer in people drinking river water was considerably higher compared to people drinking well water. Monitoring data showed high levels of ammonia, nitrite, chloride, COD, and heavy metals such as lead and mercury, indicating that drinking polluted water is one of the causal factors for stomach cancer.[32] In Baoding city in Hubei province, Hu (1994) reported that the mortality rates for liver and esophagus cancer among residents relying on groundwater that was contaminated by sewage was significantly higher compared to people in the control area.[33] Pan and Jiang (2004) investigated the correlation between various water quality indices in drinking water and the mortality rates of a range of cancer types in the Yangtze and Huai He river basins in the period 1992–2000. They discovered a significant positive correlation between the level of COD, fluorine, and chloride, and male stomach cancer. [34] There are a number of studies in China that have investigated the correlation between water pollution and infectious diseases. This is an important area of medical research investigation since chronic infection has been identified as a risk factor for numerous forms of cancer. Pan and Jiang also investigated the link between coliform group bacteria and the IWQI (integrated water quality index), which includes a broad range of water quality indicators, in drinking water and the incidence rates of infectious diseases in the Yangtze and Huai He River Basins in the period 1992–2000. The research identified strong correlations between the level of coliform group bacteria in drinking water and the incidence rates of diarrhea and between the IWQI and incidence rates of typhoid/paratyphoid and diarrhea for both men and women.[35]

A long-term study completed in 2011 by the Chinese Ministry of Environmental Protection and the Chinese Academy of Engineering, noted that over 90 percent of the groundwater in cities was polluted to different degrees and of the 118 major cities, 64 had seriously

contaminated groundwater supplies. A stark example is the Songhua River pollution catastrophe in 2005 when a chemical plant released approximately 100 tons of the highly toxic chemical benzene into the river. Subsequent to the accident, Chinese authorities conducted inspections of 127 major chemical and petrochemical plants. The inspection determined that many of the plants were situated dangerously close to major bodies of water. The plants, involved in the production of ethylene and methanol and the refining of oil, are located along the Yangtze River and Yellow River. The Yellow River is so deeply degraded by pollution that 30 percent of the fish species are believed to have become extinct according to environmental reports. The Chinese Government's twelfth five-year plan (2011) is welcome in terms of its greater transparency in addressing the severity of the environmental threats from water and air pollution that confront the population. The plan highlights major areas for immediate redress. "Firstly, the pollution type is complex, the scope is extensive and the exposure population is large; Secondly, people's exposure to the pollution is long, the exposure level of the pollutants is high, the impact of the pollution accumulated historically to the health cannot be eliminated in a short period of time. Thirdly, the difference between urban and rural areas is distinct. Air pollution is the main environmental health problem in urban areas, while water and soil pollution are the main problems in rural areas. Fourthly, while the traditional environment and health problems caused by the inadequate sanitation infrastructure have not been properly solved, the environmental pollution and health risks brought by the industrialization and urbanization process are gradually increasing. From the perspective of a development trend, the problems of the above four aspects cannot be solved in a short period of time, the health risks caused by the future environmental pollution will gradually increase, the environment and health work faces a severe situation."[36]

The recent emergence over the last three to four decades of *Aizheng Cun* or cancer villages has been duly acknowledged by Chinese authorities. In the new era of environmental concern and openness that is emerging in the country, the government has opened the door to permit greater study and debate about the cancer epidemic. The cancer village phenomenon reflects the Third National Survey on Causes of Death, which found a rapidly rising death rate due to cancer in China.[37] In the past 30 years, death rates due to lung cancer increased by 465 percent and lung cancer has become the most deadly cancer in China. Cancer, the number one cause of death in urban China, accounts for 25 percent of deaths. In the rural areas, it is the second highest cause

of death (after cerebrovascular disease), responsible for 21 percent of deaths. However, the rural areas have experienced higher mortality rates than the urban areas from liver, stomach, esophageal, and cervical cancers.[38] In particular, the survey included 13 areas where cancer villages had been reported. Four of them have cancer death rates above the national average: Yingdong District of Xinyang in Anhui, Shenqui and Jun Counties in Henan, and Yingcheng in Hubei.[39] The survey was conducted at the county level and was not designed to confirm cancer village reports. However, Ministry of Health officials admit that the high death rates in the four areas were due to concentrations of cancer deaths in some villages, which agrees with cancer village reports by the media.[40]

In Hebei, COD has been discovered at levels exceeding 1,300 mg, a highly dangerous health level considering that a reading of just 25 mg is necessary to downgrade a water body to a level 5 classification which is the worst water health level. In Xiaojizhuang Village in Hebei, one out of ten people had died of cancer, while fertile fields became barren.[41] As the issue becomes more prominently noted in medical research, scientific journals, and mainstream media, the findings are cause for alarm. Jingxing Lin, Director of the Center for Modern Ecological Geology at the Chinese Academy of Geological Sciences has examined Longling, a cancer village in Shaanxi. "With a population of 154, the village had its first cancer victim in 1974. By 2001, 36 villagers had died of cancer and 22 had died of heart and brain diseases. Only four of the 30 families had not had a cancer victim, while cancer killed four entire families."[42] Air pollution from nearby fertilizer and steel factories were regarded as the cause. Many cancer-causing metals were found, several times exceeding the safety limit, in the villagers' hair, buildings, fields, and crops.[43] The increasing number of cancer victims and devastated villages forced officials and even the media to examine the issue more closely. Tianjin government records showed that cancer rates were 1.3 and 2.1 percent in Xiditou and Liukuaizhuang villages, respectively, and 0.12 percent in Tianjin, significantly higher than the national average of 0.07 percent.[44] The cancer epidemic in rural China is primarily caused by polluted water while the urban cancer rate rise is believed to be largely caused by toxic air pollution. Based upon 2011 figures, the most common forms of cancer in males were lung (351,713 cases, 21.7 percent of all cancers), stomach (315,843 cases, 19.5 percent), and liver (292,966 cases, 18.1 percent). For women, the most prevalent cancers include lung (170,337 cases, 14.3 percent), breast (169,452 cases, 14.2 percent), and stomach (148,596 cases, 12.4 percent). In one study

it has been reported that cancer villages emerge when the river water quality is Grade 5 or worse, indicating a correlation between water pollution and cancer villages.[45]

In China, Hebei and Henan provinces have the highest number of officially reported cancer villages. According to a recent analysis of cancer provinces and villages,

> the top-12 provinces include six coastal provinces with their six neighboring inland provinces. These provinces form a cancer-village belt in eastern China, starting with Hebei in the north and ending with Hainan in the south. The belt includes 396 cancer villages–86.3 percent of the country's total–and 203 officially reported cancer villages–84 percent of the country's total. Those provinces also have the largest number of cancer counties (Table 1), adding up to 174 (78 percent of all cancer counties in China). The belt contains over 55 percent of China's population and over 59.3 percent of China's gross domestic product (GDP). It contains all China's most developed areas as well, except for Shanghai, Beijing, and Tianjin. However, there is a large income gap within the belt between the wealthy coastal provinces and their poor inland neighbors. For instance, Zhejiang and Jiangsu's per capita GDP is about three times that of their inland neighbor Anhui.[46]

One of the worst provinces in China for cancer rates and water contamination is the Henan province. It is situated in eastern central China, on the plain between the Yellow and Huaihe rivers. Henan covers an area of 167,000 square kilometers. Shenqiu, a county in the poorest region of the province has the largest cluster of cancer villages in the country. Huai River is notorious for extreme water pollution levels. Shenqiu's Zhouying Township, with a population of about 51,000, has the most severe cancer cases with 21 officially reported cancer villages.[47] The rate of death in Huangmengying village increased from 5 in 1,000 in 1990, to 8 in 1,000 in 2004.[48] "Liver, rectum and stomach cancers, mostly cancers of the digestive system, claimed the lives of 118 villagers, about half of all deaths, out of 2,400 residents between 1994 and 2004. All water in the river, ponds, and channels was at Class 5 or worse."[49] Now that the crisis of cancer villages has been fully acknowledged by the Chinese government and widely reported in the media, there will be greater focus upon the dangers of chronic pollution both from a human suffering and economic loss vantage point.

Rural China: Contaminated Drinking Water

It is widely recognized by the Chinese government and confirmed in academic research that the quality of drinking water in rural China is vastly inferior to the urban areas. In Chongqing province, the rural population is threatened by inadequate drinking water supply and high rates of water contamination in groundwater thus exposing the rural population to higher rates of waterborne disease including chronic illness such as cancer. In China, water quality monitoring is divided into five grades of purity. Grades 1, 2, and 3 denote water quality that is good. This grade of water in general is safe for consumption. Grades 4 and 5 denote water that is contaminated and unfit for human use or even bathing. In 2009, the Chinese Ministry of Environmental Protection (MEP) stated that 18.4 percent of 408 sections of 203 rivers were graded worse than the Grade 5 standard. In 2009, of all the 408 of 203 river sections, 57.3 percent met the Grades 1–3 surface water quality standard; 24.3 percent met Grades 4–5 standards; and an alarmingly high 18.4 percent failed to meet Grade 5. A World Bank study on water quality in China noted that

> monitoring of drinking water across rural areas in Chongqing shows that the level of the coliform group bacteria (an indicator of fecal contamination) in non-piped drinking water is about ten times the level in piped water, and there are more frequent incidents of extreme bacteria levels in the rural non-piped water. In Chongqing, only around 30 percent of the population has access to piped water, and most of this population reside in the largest urban centers. However, only a fraction of the piped water supply undergoes comprehensive treatment before it reaches the end users. Among the 10 counties and urban districts for which detailed information of water supply is available, the share of the population that has access to comprehensively treated piped water is less than a third in all counties/districts, and on average only 15% of the population has access to comprehensively treated piped water.[50]

The government of China acknowledged in its twelfth five-year plan released in 2011 that there are glaring gaps between the rural and the urban development that extend particularly to areas of water security and health. In rural China, a large percentage of underground water is from shallow wells and many are contaminated by sewage

and industrial pollution. Moreover, water is severely affected by contamination, including bacterial contamination, which is found in both open water sources and shallow wells. The rural population of China, where poverty and disease rates are highest, is 656 million (2012). Approximately 95 percent or rural people lack adequate sanitation and 360 million rural people lack access to safe drinking water. In addition, over 30 percent of industrial waste water and about 90 percent of household sewage in China is dumped into rivers and lakes untreated. China has 275 cities and at least 80 percent of these population centers have inadequate or no sewage treatment systems. The risk of bacterial infection from water sources with untreated sewage is substantial and another factor in the waterborne disease health burden facing China.

In rural China, millions of citizens rely upon wells for their primary water source. Yet many wells are degraded by pollution and inadequate maintenance thus exposing the population to serious health risks. A recent study on water quality in rural China noted that "in the rural areas around Beijing, there are 3,952 water wells which all are used for public water supply. There are approximately 3,590,000 rural inhabitants who depend on these wells to meet their daily water needs. The sanitary status of drinking water in rural areas is poor. Seventeen percent of wells are in the vicinity of contamination sources such as sewage ditches (carrying wastewater from homes, businesses, and industries), landfills, village dry toilets, livestock farms and polluting industries."[51] Drinking water in many of China's rural areas is unhealthy with 44.36 percent failing to meet government standards and most people living in the rural areas do not have their drinking water disinfected, and bacterial contamination has been regarded as the greatest potential problem impacting drinking water.[52] There are numerous health complications that arise from contaminated well water. The health effects from contaminated well water, as with general groundwater sources, include gastrointestinal disturbance and organ damage from the ingestion of chemical and bacterial agents. The substances that often enter wells include bacteria, sewage, total coliforms which are a group of bacteria that are found in the environment, *E coli*, Nitrates, and Pesticides. It is vitally important to maintain wells properly and also to have proper construction, a sufficient depth, and an effective seal. Well water is often compromised by seepage from surrounding soil and nearby contaminated water sources.

Bacterial and chemical contamination is a constant danger to wells particularly in the rural, underdeveloped environments. A recent study noted a significant observation that "the well-sealed / unsealed,

wellhead above/below ground and well housing/no well housing influenced the microbial indicators significantly. The proportion of well seals in Miyun, Yanqing, Huairou and Fangshan districts was no larger than 75%, the proportion of above ground wellheads in Miyun, Yanqing, Huairou, Mentougou and Fangshan districts was less than 70% and the proportion of well housings in Miyun, Yanqing, Huairou, Mentougou and Fangshan districts was no larger than 52%, indicating that wellhead protection was bad and bacterial contamination may be serious in these districts."[53] In China, tube well construction commenced in the 1950s and increased exponentially in the following decades. According to some estimates there were over 10 million tube wells by 2012. Contaminated well water is only one feature of the water pollution crisis confronting rural China. A stark example is the 2009 incident in Shaanxi, western China, whereby a six-year-old 100,000-ton zinc smelting and 700,000-ton zinc coking factory was blamed for lead poisoning in the local population. It was widely reported in the *China Daily* that the blood test results of 731 children under the age of 14 monitored in villages closest to the project revealed 80 percent had excessive lead contamination. Inadequate industrial regulations and weak environmental standards and enforcement contribute to these incidents all across China.

Environmental Challenges

Water scarcity and falling water tables are two serious water security issues facing China. The problem is most severe in northern China which is already burdened by recurring drought. Water scarcity has led China to depend heavily upon groundwater which has inevitably caused the lowering of groundwater reservoirs to dangerously low levels. A study on groundwater reserves in northern China by Yong offered a stark warning for future water availability. "Northern China accounts for 45.2% of the total population, but occupies only 19.1% of the country's water resources. This distributional discrepancy has created extremely low water availability in many local areas to the north of the Yellow River. In particular, in the Yellow (Huang) Huai-Hai river basins where megacities like Beijing and Tianjin locate, the volume of renewable water resources ranges from 314 m^3 per capita per year in the Hai River basin to 672 m^3 per capita per year in the Yellow River basin, which are below or close to the threshold level of 500 m^3 per capita per year commonly regarded as an indication of absolute water

scarcity."[54] China finds itself in a situation of extreme regional disparity regarding water use and availability. The north has the lowest water table levels on average and highest rate of drought. Conversely, southern China has recurrent flooding yet the highest water tables on average. Moreover, the four northern river basins hold less than 20 percent of national water resources but have 65 percent of farmland and 45 percent GDP. The southwestern region has 21 percent of water resources but contributes only 8.3 percent of GDP.

China secures about 81 percent of its total water supply from surface water and 18 percent from groundwater, with about 1 percent from other sources. Groundwater overexploitation is leading to a lowering of water tables and the eventual exhaustion of groundwater reservoirs, as well as extensive subsidence in many major Chinese cities. An over reliance on groundwater is a threat because it has a much slower replenishment rate than surface water. Additional research indicates that both deep and shallow aquifers in the Hai River basin have fallen dramatically whilst the Beijing underground levels have dropped 100–300 meters in recorded history.[55] Further studies have highlighted the seriousness of the water depletion trend in the core city of Beijing. A survey conducted by the GEMI (Geological Environmental Monitoring Institute) in Beijing, reported that "under Hebei Province in the heart of the North China Plain, the average level of the deep aquifer dropped 2.9 meters (nearly 10 feet) in 2000. Around some cities in the province, it fell by 6 meters. He Qingcheng, head of the GEMI groundwater monitoring team, noted that as the deep aquifer under the North China Plain is depleted, the region is losing its last water reserve–its only safety cushion."[56]

Climate Change

The effects of climate change for China are both serious and for the most part unavoidable. There are several pronounced threats facing China which include: rising temperatures, flooding, drought, increases in certain tropical disease such as malaria due to a predicted rise in the mosquito population, melting glaciers, receding farmland in some parts of the country, flooding of lowland communities and cities such as Shanghai, extremes in temperature, affected growing seasons in the agricultural sector, and variations in the rainy seasons. A 2011 report titled *China's Rising Climate Risk* warned that nine Chinese provinces already suffer from extreme water scarcity and cautioned that "14 out of 31 provincial economies could be at risk from water stress

since they rely heavily on water for everything from power generation to manufacturing."[57] In March 2012, Li Keqiang, China's premier warned that "drought and water shortages are severe restrictions on the country's social and economic development."[58] In March 2010, severe drought affected most of southwest China. Over 51 million citizens faced water shortages, damages to agricultural crops, and other health and economic losses.

Other impacts of climate change are noticeable and increasing in frequency. The glacier zone in northwestern China shrunk by 21 percent and the thickness of frozen earth in Qinghai-Tibet Plateau was reduced in size by an estimated five meters in the last 50 years. Desertification is another serious development that is a concern to Chinese authorities. Parts of northern China will potentially become dustbowls due to drought and minimal water tables thus forcing tens of millions of citizens to migrate. In China, desert expansion has accelerated in each decade since 1950. Since 1960, an estimated 24,000 villages in northern and western China have been abandoned due to desertification. This trend is likely to accelerate. Desertification in China will impact 30 percent of the territory and up to 400 million people. "Land desertification occurs mainly in the arid, semi-arid and dry sub-humid areas in the western part of northeast China, the north part of northern China and most parts of northwest China. Desertification caused by wind erosion totals 1 533 million km^2 and is distributed in barren and dry grasslands east of the Helan Mountains and Wushiaoling Ridges. It is most serious in the transitional and marginal agriculture and animal husbandry zones of 11 provinces and autonomous regions: Xinjiang, Inner Mongolia, Gansu, Qinghai, Ningxia, Shaanxi, Shanxi, Liaoning, Jilin, Heilongjiang and Hebei."[59] Conversely, in different regions of China, scientists are predicting the shrinkage of wetlands and inland lakes. It is estimated that glaciers in western China will be reduced by about 28 percent by the year 2050.

It is clear that Chinese authorities have recognized the severity of the problem and are activating specific plans to address it. China has already witnessed in stark terms the adverse effects of climate change on water security. For example, "in the Yellow River basin, average temperatures have increased while precipitation and river runoff have decreased in the past 50 years. In the past 20 years, climate change has decreased water resources in northern China, with the annual flows of the Hai, Yellow, and Huai Rivers reduced 41%, 15%, and 15%, respectively. In addition, the loss of glaciers and wetlands upstream from the Qinghai-Tibetan Plateau has decreased river runoffs by 917 billion cubic meters

over the past 50 years and will lead to an annual loss of 143 billion cubic meters in the future."[60] The acceleration of water scarcity and adverse simultaneous effects of climate change will inevitably impose a measure of urgency upon Chinese policymakers in the decades to come.

The Yellow River

The Yellow River has deep historical meaning and is emblematic of the Chinese civilization. It is the second longest river in China and stretches 5,464 km from its source in the Tibet plateau. It flows through the Qinghai, Gansu, Ningxia, Inner Mongolia, the border of Shaanxi and Shanxi, Henan, and Shandong then completes its journey in the Yellow Sea. It is estimated that 160 million people receive a water supply from the river and irrigation is provided to 15 percent of national farmland. That such a vital river has been allowed to degrade to such a low level is a national environmental catastrophe. Indeed, the Yellow River represents a classic case of lax government environmental policy and ecological destruction. The river traverses major industrial zones including the coal producing zone. The Chinese government has estimated that about 65 percent of the Yellow River's water is too polluted to drink and according to the Institute of Public and Environmental Affairs, a Beijing-based NGO, 4.3 billion tons of waste flowed into the Yellow River in 2005 alone. Moreover, 30 percent of fish species in the river are believed to have become extinct and the river's fish catch declined by about 40 percent. An estimated population of 110 million people live along the Yellow River in the semi-arid North China Plain. Since the 1970s, the Yellow River, due to massive water withdrawal, has not reached the Yellow Seas for parts of the year. In 1995–1998, the Yellow River failed to reach the sea for about 120 days each year. Major government initiatives have had some success to the point where desiccation has been slowed and the Yellow River has reached the sea since 1999.

Studies by the Yellow River Conservancy Commission indicate that "the water quality of the Yellow River is affected by wastewater discharge from industries, sewerage outfalls, urban runoff, and excess fertilizer and agricultural waste washing into the river, plus contaminants associated with the naturally high sediment load. Water quality is also dependent on the flow in the river. The official target for the lower Yellow River is Grade III, although the aquatic health would benefit from achievement of a higher water quality grade. Towards the end of the 1990s and in the early 2000s the water quality of the lower Yellow

River was below the Grade III for much of the time. The reduction in pollution generation from urban and agricultural areas, plus the better quality of the river water, has improved the quality of life for those living along the river." [61] According to some reports, about 1 million tons of untreated sewage are deposited into the river each year from the city of Xian. The river also accumulates pollution from other cities and towns. The Yellow River Conservancy Committee, which surveyed more than 8,384 miles of the river in 2007, reported that 33.8 percent of the river system registered pollution that was worse than Level 5. An estimated 4,000 petrochemical plants are situated along the Yellow River and sewage discharged into the system in 2012 totaled 4.29 billion tons.

Government Water Policy and Laws

China has massive land mass at 9,569,901 km, the third largest in the world, the largest population in the world, and a diverse climate that ranges from drought to flooding. Naturally, government policy and enforcement to keep pace with the urgency and breadth of water security is complex. The following agencies, policies, and procedures highlight major initiatives by the government of China in recent years. The MWR (Ministry of Water Resources) is a Department of the state council and is responsible for the administration of water in China. It controls the state water budget and conducts the following major functions:

Formulate water-related policies, development strategies, and development plans.

Develop legislation on water drawing, pricing, and tariff regulations.

Monitor and launch plans on water quality, supply, and demand.

Assess flood risk and flood mitigation in relation to urban planning.

Develop regulations for water resource and environment protection.

Guide efforts for the protection of water bodies, dykes, dams, and coasts.

Supervise the Flood and Drought Prevention agencies.

The MEP (Ministry of Environmental Protection) shares most responsibilities for water security and policy with the MWR (Ministry of Water Resources).

In 2008, three new departments were created, the Department for Control of Pollutant Discharge, the Environment Monitoring Department, and the Department of Publicity and Education.

The 1979 Environmental Protection Law was passed.
The 1984 WPPCL (Water Pollution Prevention and Control Laws) was passed.
2008 Legislation on Environmental Information Disclosure is passed.
The 2004 Guidelines to the Rule of Law passed which becomes a legal support for environmental groups to become engaged in the planning and decision-making processes of large projects.
In 2007, the Chinese government announced specific targets regarding climate change to be met by 2020. These targets include:

(1) To significantly improve the capability for making independent innovations in the research on climate change;
(2) To make breakthroughs in and wider applications in social and economic sectors of key technologies related to GHG (green house gas) emission control and climate-change mitigation;
(3) To notably enhance the adaptive capacity of key sectors and typical venerable areas in response to climate change;
(4) To markedly improve the ability of S&T (Scientific and Technological) support to international cooperation, engagement and decision making on climate change;
(5) To make substantial progress in building up the climate-change disciplinary, and in improving S&T infrastructure, research conditions and qualification of research teams;
(6) To noticeably increase the public's awareness of climate change and related scientific knowledge.

The short-term goals of the eleventh five-year plan period (2006–2010) are:

(1) To put in place a national S&T policy framework and coordination mechanism in response to climate change and to further improve the capacity of integrating S&T resources;
(2) To achieve internationally recognized research findings in key climate-change areas;
(3) To develop and improve Chinese prediction, analysis, assessment, and decision-making models on climate-change;
(4) To advance research on key technologies for climate change mitigation and to launch pilot projects at local level and in industrial sectors;
(5) To make breakthroughs in the studies on the impacts of climate change on agriculture, water resources, coastal areas, forestry,

fishery, biodiversity, desertification, and human health and to implement demonstration projects on adaptation in typical vulnerable areas;
(6) To formulate the National Adaptation Strategy on Climate Change;
(7) To make China's contributions to the design of international climate-change regime;
(8) To build up highly professional research teams as well as research bases on climate change.

In response to the worsening water scarcity problem, the Chinese government has adopted the SNWTP (South North Water Transfer Project). The goal of the SNWTP is to transfer about 45 billion cubic meters of water per year from central and southwest China to augment the flow of the Yellow River and meet the urban water demand in the Beijing-Tianjin region. The project will use eastern, central, and western routes to transfer the water in a massive engineering project. The eastern and central routes will be channeled under the Yellow River. The western route involves pumping water at elevations of 10–16,000 feet above sea level over parts of the Himalayan mountain range. Cost estimates are USD 62 billion.

Other major government initiatives include: 1991 the government announced policies on Desertification control and the effective usage of sandy deserts to facilitate enforcement of these laws. A 2002 Water Law established a licensing regime that places all water resources under state control. In 2010, China's Communist Party Central Committee and State Council announced a "three red lines" policy to establish set limits on water quantity usage, efficiency, and quality. The policy will limit total national water consumption to less than 700 billion cubic meters per year or 75 percent of China's total annual exploitable freshwater resources.

Water Development Project Profiles

Case Study: Storage and Use of Rainwater in China Hebei, #352

Overview

Hebei province is located in Haihe water basin in North China Plain. Its area is 187,700 square kilometers, in which cultivated land is 6,120,000 square hectometers. The population is 68,000,000. Water

resources amount to 306 cubic meters per capita. This represents only 61.2 percent of international criteria of extreme scarcity of water (500 cubic meters/capita). The rate of use of runoff in river is more than 90 percent, more than the double of the bottom line of international ecological environment requirement (40 percent). Due to scarcity of water, the impact on grain yield is more than 3 billion kilograms; on industrial output is dozens of billion Yuan. It causes a series of ecological and environmental problems such as a drying of rivers, degradation of wetland, intrusion of seawater, extension of seawater, serious overexploitation of ground water (more than 100 billion cubic meters), subsidence of land surface and buildings. The average rainfall is 532 mm in the province, with very uneven distribution, in which 13 percent is in the peak time of water use. It makes drought more obvious; 70 percent–80 percent is in the wet season, which is apt to cause floods. How to use the storm water resources is one important step toward the solution of water scarcity.

Action Taken

Hebei provincial government has attached a great importance to the scarcity of water. It has given a full support to the use of storm water. In 1989, the guidance on "focus both on flood and drought control" and "focus on prevention, integration of storage and discharge, scientific regulation, full effort on security, and more storage" were developed. The following principles were applied:

1. Improving soil and water conservancy and vegetation cover. The "Three North" protection forest belt and forest in water source areas was constructed with the combination of perennial woods, bushes, and grasses to increase the vegetation of forest and grass, water conservation engineering and green area to decrease water and soil erosion, and increase the interception and storage of water on leafs and land surface.

2. Modifying the cultivation structure to use more rainwater for farm land. Crop varieties which grow at the peak time of heat and rainfall were recommended together with moderately postponing of the seeding time of crops, fully use soil water to improve the capability of drought resistance of crops and penetration of water into soil.

3. Employing the water works to harvest rainwater. Several applications of engineering facilities were employed to harvest rainwater. These included small dams, ponds, lakes that store water and at a mean time to mitigate impact of flood risk.

4. Establishing ties between watercourses. The connection between watercourses forms integrated network of dispatching water. Through the ties, the watercourse, during flood season, provides more storage to the dry zones. The connection contributes to flood control, drought relief, and rational rainwater distribution.

5. Modeling of hydrogeological and hydrographical scenarios to model flood forecasts. Hi-tech models were applied in the area to assess and forecast water table levels and limits in flood season. The reservoirs in large and middle scale are installed with automatic flood forecasting system supervised by computers. With the digital information, the experts group makes analyses to enhance the capacity in forecasting and working on flood control and rainwater storage. This allows for flexible regulation of flood water.

Achievements

Multilateral cooperation Office of State Flood Control and Drought Relief Headquarter, a composer of rainwater dispatching scheme, convenes 19 sectors, including planning, finance, metrology, agriculture, forestry, environmental prevention, civil affairs, communication, transportation, construction, and so forth, to implement the operation and distribution of rainwater.

Annual training course. As an element in capacity building, local authorities and individuals are given the training course at all levels (county, city, town, and village). Training has been conducted toward effective storage and use of rainwater each year.

Control of pollutants. The total quantity control of water pollution, issued by the Ministry of Environmental Protection, is a principal standard filtering polluted ones. The rainwater harvesting from floods shall meet the standard of total quantity control of water pollution.

Mixed results. The results of storage and use of rainwater are mixed. In other words, its contribution can be presented from trilateral aspects, including flood control, more water resources against drought, and ecological environment. This case has been implemented along with state master plan of flood control and drought relief which is effective for flood fighting and diversion. On the other hand, rainwater, as available water resources, is able to alleviate water shortage particularly in the dry season or dry zones. Concerning the improvement of ecology and environment, in mid-August in 1996, extreme heavy flood occurred in the mid-south part of Hebei. Through the use of the above methods, it stored an extra 1.7 billion cubic meters of surface water

in that year, recharged into ground water 7.5 billion cubic meters and increased soil water about 10 billion cubic meters, also rushed away large amount of effluents and pollutants. It plays the role of mitigation of flood disaster and improvement of ecological environment.

Outcomes

Scientific regulation of storm water is an effective measure of increasing available water resources. The successful use of storm water must be supported by reliable flood control engineering facilities, scientific regulation plan, and decision-supporting system that is integrated by automatic monitoring and specialists, unified regulation of commanding stations at various levels. Adherence to the guiding concept of "people are the fundamental, safety is the first" and working principle of "plan from the worst point, effort towards the best point": scientific regulation and storage of flood water in the precondition of security.

(Source: Wei Zhimin, GWP Hebei, Department of Water Resources of Hebei province, China)

The North China Plain Water Conservation Project

The North China Plain is one of the most densely populated regions in the world that contains the capital of Beijing. Water scarcity is a growing problem in the region. Action has been taken by the North China Plain Water Conservation Project that is focused upon constructive use of water resources, agriculture production capacity, and farmer incomes. A major finding of the project is the need to provide incentives to farmers.

Water supplies to agriculture are under the stress of excessive use and population pressure. The North China Plain Water Conservation Project financed by the World Bank (USD 74 million) aimed to enhance beneficial use of water resources, agriculture production capacity, and farmer incomes.

There are four main components to the project:

1. Irrigation and drainage works and on-farm systems, including canal lining, low pressure pipes, drains, wells, surface irrigation improvements, sprinklers, and micro irrigation systems.
2. Agriculture support and services, including land leveling, non-tillage in the dry season, deep plowing in the rainy season, soil fertility improvements, organic and plastic mulching, cropping

pattern adjustments, seed improvements, balanced fertilization and improvements to planting and cultivation techniques.
3. Forestry and environmental monitoring of the project's impact on soil and water.
4. Institutional development and capacity building for water and soil conservation.

Project Benefits

Increased water productivity and reduced consumptive use. The value of agricultural production per unit of water consumed increased in the range of 60–80 percent, agricultural production tripled and farmer per capita incomes increased between 10 percent and 500 percent.

More sustainable groundwater use. Groundwater depletion was reduced to negligible levels or eliminated.

Strengthened institutions arrangements for irrigation system operation and maintenance. The original project target was 100 WUA (water user associations), but more than 500 were established. For the first time on this scale in China, WUAs assumed responsibility for both financing and operating irrigation systems.

Water charges. Volumetric water charges were initiated.

Development of WUAs. The success of the WUAs stemmed from two principles: (a) democratic self-organized associations based on hydraulic boundaries, and (b) water measuring with corresponding water charges on a volumetric basis. Important factor was also inclusion of farmers from the onset and support of both the Ministry of Water Resources and local governments.

Importance of economic incentives. Approaches to water savings in agriculture are more likely to succeed if appropriate incentives are given to farmers to modify their practices. *Monitoring and evaluation for technical innovations.* An appropriate monitoring and evaluation system is necessary to verify efficiency of integrated water saving measures in agriculture, and to share the information with WUAs.

(Source: China: Innovative Water Resource Conservation Measures in the North China Plain (#348) Global Water Partnership, 2012)

The Huai River Pollution Control Project

The Huai River Pollution Control Project goal is to improve the water quality in the Huai River Basin in the provinces of Anhui, and

Shandong, through improved collection, and treatment of wastewater in the municipalities of these two provinces. The two main components will:

(1) support wastewater investments in the Anhui province in eight municipalities, through the implementation of the first phase of the wastewater master plan. Investments include the construction of secondary sewers, and house connections; interceptors; pumping stations, and pumping/transmission mains. In addition, construction of WWTPs will also be financed in Guoyang, and Luan municipalities. The capacity of the Anhui Environmental Monitoring Center will be strengthened, by upgrading its equipment, and municipal laboratories, providing vehicles for field sampling; and improving technical, and managerial skills. TA (technical assistance) will be provided for institutional development, for construction management, and will support staff training as well.

(2) support wastewater systems investments in the Shandong province to three municipalities, and in Juxian, Rizhao. It includes construction of secondary sewers, and house connections; interceptors; pumping stations, pumping/transmission mains; and WWTPs.

The HRB (Huai River Basin) is located in the provinces of Henan, Anhui, Shandong, and Jiangsu, and covers an area of 270,000 square kilometers between the Yangtze River and Yellow River. Of the 315 million people who live in the four provinces, about 45 percent reside in the Huai River catchment region. The HR (Huai River) was one of the most polluted rivers in China with water quality classified as Class 4 or worse. Pollution has been mainly due to untreated industrial and domestic wastewater discharges, and nonpoint agricultural source pollution. The environmental impacts of water pollution in the HRB were extremely acute. Improving the water quality in the HRB was a key program in the ninth five-year plans (1996–2000) of the four provinces. Starting in the late 1990s, significant efforts were made by cities in the HRB to construct WWTPs (wastewater treatment plants) and control pollution from industries. However, municipal wastewater control, using bilateral funds, focused more on the construction of treatment plants, with little corresponding effort on the sewage collection. This would have led to nonoperational WWTP with little or no flows. The overall program therefore could not achieve the objectives set for 2000 without a massive program for construction of collection sewers. To correct this, the HRPCP (Huai River Pollution Control Project) focused on supporting the efforts of the governments and cities to meet the pollution control targets in the HRB by financing the construction of sewers, municipal WWTP, major industrial control facilities,

and institutional strengthening as well. This was carried out in 12 cities in the HRB within Anhui and Shandong provinces. The project addressed the key environmental issues in accordance with national and provincial priorities, as well as the bank's country strategy.

Project: Major Beneficiaries

About 400,000 additional people (total revised project beneficiaries: 3.7 million people) benefited by the expansion of wastewater service coverage that resulted from the construction of additional sewer mains using loan savings in Anhui and Shandong provinces. Eight cities in Anhui province, and four cities and one paper mill in Shandong province were selected for project intervention, as summarized in the component description below.

Component 1: Anhui Province (USD 152.08 million)

The component consisted of: (a) wastewater collection and treatment: construction of 633 km of interceptors, secondary sewers, house connections, pumping mains; 29 pumping stations in the eight municipalities of Bengbu, Bozhou, Fuyang, Guoyang, Huaibei, Huainan, Lu'an, and Suzhou, and two WWTPs, of 40,000 cubic meters per day capacity each, in Guoyang and Lu'an; (b) environmental monitoring: strengthening the environmental monitoring capacity through equipment for the monitoring center and laboratories, sampling vehicles and skills enhancement for technical and managerial staff; and (c) institutional development and capacity building: institutional development for wastewater companies, construction management, and training.

Component 2: Shandong Province (USD 74.81 million)

The component consisted of: (a) wastewater collection and treatment: construction of 169 km of interceptors, secondary sewers, house connections, and seven pumping stations in the three municipalities of Feicheng, Heze, and Rizhao and the county town of Juxian, including treatment plants in Feicheng (40,000 m^3/d), Heze (80,000 m^3/d), and Rizhao (100,000 m^3/d) including a 3 km sea outfall; (b) industrial pollution control: construction of a black liquor treatment plant (1,200 m^3/d) and a WWTP (20,000 m^3/d) at the Chengwu Paper Mill; and (c) institutional development and capacity building: institutional development for wastewater companies, construction management, and training. At the time of project approval, wastewater treatment plants were under construction in the six other municipalities, supported by bilateral financing and/or national programs.

Key Factors and Outcomes

Project preparation and design. The project was designed to complement the ongoing efforts in Anhui and Shandong provinces by focusing on investments in the municipal wastewater sector. The project sought to maximize benefits through financing collection sewers in cities where treatment capacity was being created with other funding but where there was a lack of adequate collection sewers. The Shandong province component also addressed wastewater management more broadly, by including a focus on two additional facilities, both of which were major polluters in their region. These were the wastewater facilities in Rizhao, whose pollution discharges had an impact on the Bohai Sea, and the Chengwu Paper Mill, which had high mercury pollution from its electrolytic process.

The AHPCP is an important project for the Anhui province to markedly reduce pollution and to create a sustainable environment for economic and social development.

(Source: Document of The World Bank, Report No: ICR0000609, Implementation Completion and Results Report [IBRD 4597-CHA].)

Interview with Dr. Pan Tao

Dr. Pan Tao is the founder of a China-based think tank, the ISEE (Institute for Sustainable Environment and Energy). He is also the founder of the Eco-land Club Farm, the first Shanghai-based community garden. Dr. Pan Tao has more than ten years of practical, applied experience in urban sustainability planning and implementation, and has worked on successful environmental planning and management, decentralized wastewater management, energy efficiency, and GHG reduction initiatives in cities across China, filling the gap between policy and practice. Prior to ISEE, he served as the China urban program director in the ISC (Institute for Sustainable Communities) for the US-China PCA (Partnership for Climate Action), a public-private partnership supported by numerous Chinese and US government agencies, and by top multinational corporations. Prior to ISC, Dr. Pan Tao worked as a technical advisor for the Clinton Climate Initiative (C40-CCI) and the German Technical Cooperation (GTZ) Eco-City planning and management program. He holds a doctorate in environmental planning and management from Nanjing University, a master's degree in environmental and resource management from Brandenburg Technical University, Germany, and a bachelor's degree in geotechnical

engineering from Tongji University. He is a native Mandarin speaker and is fluent in English.

Describe the current water situation in your country in terms of health, access, and scarcity.
In China, the water problem can be described as water scarcity both by quality and quantity. In the eastern region, water pollution threatens the water supply, while in the northern and western regions, lack of sufficient water source is a big problem. The over-exploration of ground water has resulted in serious ground sink problems.

What are the major waterborne diseases in your country and/or region where you operate?
The cancer village issue in China is a major health problem. Those problems are mostly caused by industrial pollutions.

What are the most significant barriers to water quality, health, and access and what is the 10-year and 25-year outlook?
In the 10-year time frame, the biggest issue is to reduce pollution and conserve more water sources. In the 25-year time frame, climate change will be a serious issue, especially the melting of the Tibet Plateau, sea water rising, and intrusion in coastal region.

Describe any groups or minorities that face specific hardships regarding water access and health.
Cancer villages in rural China.

What is being done to assist these groups at the national or local government level?
The economic motivation is too strong not to stop pollution, so I am pessimistic about those areas.

What policies is the national government developing or conducting to expand water/sanitation health and access?
The central government spent a lot of money on water projects, the access to tap water/clean water have been basically provided. However, due to corruption, the water sanitation money has not been so effective. The water pollution problem hasn't been solved.

What policies would you like to see the national government introduce to improve water/sanitation access, quality, and health?
Raising a Clean Water Fund that is transparently operated by professional entities and charities.

What environmental problems are impacting water quality?
Industrial pollution.

What are the three major steps that could be taken in the future to improve the general water health and access situation?
Step 1: Increase water supply standards.
Step 2: Raising money for the Clean Water Fund
Step 3: Transparancy of water monitoring data

Describe two or three innovative water development or rights projects that are assisting people.
In China, the South North Transfer project is very controversial. We will see how the project will be implemented. The three-Gauge dam project has also a huge impact on water supply and environment.

How important are the local NGOs and the international NGOs in protecting and advancing water rights and development in your country?
Unfortunately the NGO sector really plays a minor role. Only one project worthwhile to mention is the water pollution map developed by IPE, a China-based NGO.

Describe your own background in wate-related work and development.
I am an expert in water sanitation and decentralized wastewater solutions.

Describe the importance of improved sanitation systems for health and water safety in your country or provinces.
We should think about using more decentralized wastewater systems in the rural and the town areas.

Describe the major priorities in your own work for the next five years.
Analysis of adaptation to climate change.

CHAPTER SEVEN

The Philippines: Devastated by Climate Change

Country Overview

The Philippines is a developing country with a high rate of poverty and considerable water-related development obstacles to overcome. Income inequality is a major and ongoing development barrier. With an annual population growth rate of 2.1 percent, the country is projected to face water shortages by 2025. Nine major cities in the Philippines were classified in a 2010 study by the Japan International Cooperation Agency as water critical areas: Metro Manila, Metro Cebu, Davao, Baguio, Angeles, Cagayan de Cro, Zamboanga, and Iloilo. There are pronounced gaps in water supply and quality between the urban and the rural areas. These gaps are exacerbated by a high poverty ratio and a large rural population. The country has 7,110 islands and a land area of about 300,000 square kilometers. There are 96,000 square kilometers of agricultural land which comprises 32 percent of the total landmass. Agricultural lands and the farmers and populations they sustain will be dramatically affected by climate change. In total, there are 138 cities, 1,496 municipalities, and 42,027 barangays.

Problems of flooding, high-intensity storms, rising sea levels, and erratic temperatures will become symptomatic of climate-change effects in the country. According to a recent development report, the Philippines faces numerous water security obstacles. These include: "pollution of drainage systems and water bodies; non-treatment of domestic wastewater, sewage and industrial effluents; biological death of rivers; the accumulation and inadequate collection and improper disposal of domestic, industrial and hazardous waste, chemical and toxic

substances and hazardous wastes; polluted city air; disaster-prone or geologically hazardous areas, inadequate infrastructure, no wastewater, sewage treatment, degraded, use and disposal of industrial wastes; no governance and environmental management capacity."[1]

Major health, economic, and water indicators

Human Development Index (HDI) for the Philippines, 2014: 117
Population, 2014: 98.39 million
Gross national income (GNI), 2012: USD 3117.00
Life expectancy, 2012: female: 72.6
male: 66.0
Improved rural water source, 2012: 91 percent
2005: 87 percent
Population percentage with access to improved sanitation, 2013: 74 percent
global average: 72 percent
Rural population, 2012: 50.9 percent
Poverty index, 2012: 25.2 percent
Homeless population, 2014: 3.285 percent
Carbon dioxide emissions per capita (tons), 2014: 0.87

Although the country has significant water resources, they are threatened by high population levels particularly in major urban centers such as Manila, rapid population growth, increased industrialization, and high water demand for irrigated agriculture. Approximately 82 percent of water use is for agriculture (higher than the global average of 70 percent for most countries), 10 percent for industry, and 7.6 percent for urban use. In the crucial area of water coverage, "estimated national coverage in the Philippines in 2010 was reported to be 92%, with 93% coverage in urban areas and 92% in rural areas. In urban areas, 61% was piped onto premises and 32% came from other improved sources; for rural areas, only 25% was piped and 67% came from other improved sources. The NSO reported a slight increase in the percentage of the population with access to potable water rising from 82.9% in 2007 to 84.8% in 2011"[2] The link between poverty and water insecurity is well established. The country has a wide disparity in income levels and urban-rural development indicators. "The percentage of the population below the national poverty threshold declined from 45.3% in 1991, 32.9% in 2006 and 25.2 % in 2012. However, the country did not meet its United Nations MDG (Millennium Development Goal) target of 22.7% below the national poverty threshold by 2015. Nationally, 58% of groundwater is contaminated with coliform and out of 421

major rivers, 50 are seriously polluted and 40 have been declared clinically dead though a combination of industrial pollution and untreated household waste. Moreover, only 7% of the population is connected to a sewerage system."[3]

Manila: City Water Profile

Manila is a historic city that was founded in 1571. Today it is the leading city in the country and a major Asian metropolis. It is situated on the eastern shores of the Manila Bay in southwestern Luzon. The elevation is only 51 feet which leaves the city vulnerable to the effects of climate change including sea level rise, increased flooding, storm surges, and saltwater intrusion. The city is divided into southern and northern sections by the Pasig River which is the main waterway. The rainy season is generally from May to November when the flooding risk is enhanced. Of the 17 regions in the Philippines, the corridor comprising the urban areas of Cavite, Laguna, Batangas, Rizal, and Quezon (Calabarzon) which are adjacent to Metro Manila, is now the most populated area in the country with 12.6 million inhabitants. Approximately 98 percent of the water utilized in Metro Manila is sourced from the Angat Dam which is located 40 km northeast of Manila. Major environmental problems have been identified in the Manila Bay including low water quality, chronic pollution, sewage-chemical dumping, coastal erosion, reduced biodiversity, excess exploitation of fishing, and damaged habitats. The rivers that feed into the Manila Bay have also been affected by environmental degradation. The vast majority of pollution is caused by human activity including factory pollution. The discharge of industrial, urban, and agricultural wastewater and pollutants is largely uncontrolled. It is estimated that 21 percent of the organic pollution in the Manila Bay is derived from the Pasig River basin. Moreover, there are about 43,000 manufacturing facilities located in and around Metro Manila with high chemicals and wastewater volumes poured daily into the Manila Bay, the Pasig River, and surrounding waterways.

Approximately 44 square kilometers or 7 percent of the NCR (National Capital Region) is prone to flooding. Flooding affects 2 million people and causes economic losses of about PHP 900 million per year. The flood-prone areas include: Manila, Malabon, Navotas, Valenzuela, San Juan, Mandaluyong, Talayan-Tatalon in Quezon City, east and upper Marikina, east Manggahan in Pasig, Taguig, and Pateros. "In addition to flooding, local government units in the NCR also

must contend with environmental risks and hazards such as saltwater intrusion, which greatly affects the availability of fresh ground water for the coastal areas of Parañaque City, Pasay City, Manila, Navotas, and Malabon, and even inland municipalities like Pateros. In Metro Manila, the water tables are being drawn at the rate of 6 meters to 12 meters a year, causing saltwater intrusion into the fresh ground water along the coastal areas."[4]A continuing problem in Manila is the excessive, unsafe, and chronic dumping of garbage, sewage, and chemicals, often illegally, into waterways.

Water pollution in Manila is a serious health, environmental, and economic problem. "One major cause of water pollution is untreated domestic wastewater, which accounts for 48% of total BOD pollution nationwide (2237 thousand metric tons per year). All Manila waterways are heavily polluted and the situation is grave as described below—MM's key urban watercourses, Marikina River and Pasig River, are biologically dead. About 65–75% of pollution is caused by residential sewage, with the rest originating from industries such as tanneries and textile mills, as well as from solid waste dumped in the rivers."[5] By 2025, Manila is projected to have a population of 14.8 million.[6] Yet the much larger area of metropolitan Manila had a population estimate of 21 million in 2010 and could reach 45–50 million people by 2050. The PIDS (Philippine Institute for Development Studies) has estimated that 4 million of the 11.5 million residents in the NCR lived in slums in 2010 and with a population growth rate of 8 percent annually, the slum population is expected to reach 9 million by 2050.[7]

Health and Human Rights Challenges

The Philippines is a rapidly developing country. However the burden of widespread poverty, income inequality, inequitable access to important services, and a difficult water security scenario impede full development. Water pollution, air pollution, poor sanitation, and unhygienic practices contribute to an estimated 22 percent of all reported disease cases and nearly 6 percent of all reported deaths in the country.[8] A continuing sanitation and health problem is evident with the practice of open defecation by an estimated 8 percent of the population. Environmental standards and monitoring along with public ecological awareness are sufficient to prevent the large-scale disposal of solid wastes into waterways. In 2005, of 525 bodies of water examined by the DENR (Department of Environment and Natural Resources),

only 41 percent were classified as being of sufficient quality to serve as sources of drinking water.[9]

In 2004, 5.5 percent of deaths were due to water, sanitation, and hygiene-related causes. In response, the Philippines government Development Plan for 2011–2016 includes a focus upon enhanced infrastructure investments in water to meet demand and health requirements. The major infectious disease risk in the Philippines is high. Food or waterborne diseases include bacterial diarrhea, hepatitis A, and typhoid fever; vector-borne diseases: dengue fever and malaria; water contact disease: leptospirosis.[10] The WHO (World Health Organization) has reported that, "the Philippines continues to witness outbreaks of emerging infectious diseases including epidemic-prone communicable diseases such as dengue, cholera, typhoid and leptospirosis. Dengue, especially, has become a serious public health problem, imposing a significant burden on hospitals and other health care services. The most common disease outbreaks are food-borne and water-borne diseases like cholera, salmonellosis and shigellosis. Meanwhile, the Philippines continues to face health security threats from newly emerging diseases."[11]

A continuing poverty gap between the urban and the rural regions is impacting overall development goals and water security. Based on 2009 official poverty statistics, the poverty incidence for the country overall increased slightly, reaching 26.5 percent of the population in 2009, up from 26.4 percent in 2006, and 24.9 percent in 2000.[12] It lessened to 25.2 percent according to 2012 figures. Poverty and the multiple levels of deprivation that are associated with it are a major development difficulty for the national and regional governments. A 2014 United Nations report on climate change sends a stark warning that many of the hardest consequences from climate change will fall upon impoverished developing countries, poor populations, and those living in low-lying areas. 60 percent of the Filipino population live in coastal zones. Water security and the related impact upon health is further threatened by the fact that 58 percent of groundwater sampled is contaminated with coliform and needs treatment and many areas encounter water shortages during the dry season.

On November 8, 2013, a devastating category 5 typhoon, named Haiyan, struck the Guiuan municipality in the eastern Samar province. The path of destruction also reached the provinces of northern Cebu, Leyte, Iloilo, Capiz, and Aklan. An estimated 18 million people were affected, 6000 deaths were reported, 27,000 were injured, and 3.9 million were left homeless. Reports from the government of the Philippines and the UN Disaster Assessment and Coordination Teams

(UNDAC) on the ground noted that "all homes/buildings in the path of the storm have been seriously damaged, areas of Cebu, Roxas and Tacloban were devastated; Samar, Leyte, Iloilo, Aklan and Coron were badly hit, Tacloban City endured massive damage and large parts of the city were flattened. There were storm surges over 7 meters. Entire coastline communities washed away. Samar experienced an 80% destruction of buildings."[13] A WHO report on the impact of the typhoon noted numerous health concerns. These included, "population displacement, overcrowding, poor shelter, exposure, lack of safe water, sanitation and hygiene facilities, vector breeding and poor nutritional status, lead to increased communicable disease transmission and potential for outbreaks of diseases such acute respiratory infections, measles diarrhea, typhoid fever and viral enteric diseases—increased exposure to vector-borne diseases such as dengue and chikungunya or malaria."[14]

Environmental Challenges

The Philippines is severely affected by turbulent climate patterns and events. Moreover, human practices related to inadequate conservation, poor water management, and excessive polluting have further weakened the environmental condition of public water ways. In 2007, the Philippines Environment Monitor reported that much of the surface water in most large urban centers comprises rivers that pose a public health risk with a designation of Class C standard or below.[15] Environmental quality is further compromised by the high level of coliform bacteria in the rivers in and around Manila. "A staggering 95% of the wastewater from urban households flows into groundwater, public canals, drainage systems, rivers, and other water bodies, either directly, or after only receiving minor treatment in poorly designed or maintained septic tanks. Urban communities living close to open drainage systems and those that rely on groundwater, wells, and leaky water distribution systems for their water supply are thus at risk. Contaminated surface water from open defecation and sewage in the rural areas is also common, which threatens biodiversity and reduces overall quality of life."[16]

Among Asia-Pacific nations, the Philippines has one of the highest percentages of the population endangered by flooding and storms. The 2014 UN IPCC report notes that in the Asia-Pacific region,

> the Philippines already ranks as the second-highest in terms of the number of people exposed to storms and floods (12.1 million)

and the fourth-highest in terms of GDP value losses ($24.3 billion), according to 1998–2009 statistics compiled in the IPCC report. The number of Philippine residents exposed to storms is the second highest after Japan's 30.9 million, and is also bigger than China's 11.1 million. In terms of losses to the economy (measured by the GDP), the Philippines ranks fourth after Japan ($1.23 trillion in losses), Korea ($35.6 billion), and China ($28.5 billion). The Philippines' economic losses to storms is the highest among the developing economies in the region, according to the IPCC data.[17]

Climate Change

The adverse effects of climate change have been well documented and scientifically verified in numerous reports by the United Nations and climate-change analysts. It is further evident that the developing countries, countries with low sea level elevations, and nations with high impoverished populations will face a disproportionate share of the burdens. A risk analysis of countries most vulnerable to climate change, using 42 separate social, economic, and environmental indicators to assess the vulnerability of 170 countries, provides a negative assessment for the Philippines. The country is included in the list of 16 countries facing "extreme risk" over the next 30 years, taking into consideration factors of poverty, dense populations, exposure to climate-related events, reliance on flood and drought-prone agricultural land.[18]

Additional climate-change dangers to confront the country are evident from scientific projections related to sea level rise. The Philippines is ranked among the top five countries in the world in terms of the population number threatened by sea level rise by the year 2050. The five countries include: India (37.2 million), Bangladesh (27.0 million), The People's Republic of China (22.3 million), Indonesia (20.9 million), and the Philippines (13.6 million).[19] Moreover, the Climate Change Vulnerability Index ranks the Philippines as the sixth worst affected country in the world according to extreme climate-related events. In 2009, the Philippines topped the list of countries with the most number of reported natural disasters, it ranked third in terms of mortalities (1,334 deaths) and second in terms of number of victims (13.4 million).[20] "In the period to 2050, climate-related hazards like super typhoons and heavier rainfalls alternating with long and warmer dry seasons will exacerbate risks and in turn 'further entrench poverty' in vulnerable countries, with the Philippines seen to be one of the

developing economies that will be most at risk, according to the report by the UN-led Intergovernmental Panel on Climate Change). The report also noted the country's high sea level rise by the year 2050."[21] High sea level rise and the associated effects of flooding, coastal erosion, and salt water intrusion will have a devastating impact upon the Philippines. Moreover, the impact will exacerbate conditions in a country that already has a high poverty ratio that stands at 25.2 percent (2012). The homeless ratio of 3.28 percent (2014) is also expected to be affected. Poor, migrant, low income, and farming communities in the Philippines will likely experience a disproportionate burden from these climate-change effects.

The Pasig River

The Pasig River is designated as one of the most polluted rivers in the world. It is a 27-kilometer body of water that dissects Metro Manila. The downward spiral of environmental damage occurred over the last five decades when industrialization, pollution levels, and the urban population increased considerably. By the 1960s, pollution levels in the river were pronounced. In the 1970s, the Pasig was designated at a level below Class C of pollution and in 1975, it fell below Class C II. In the Philippines, a Class AA designation indicates water that is safe and usable for public water supply. There are only five Class AA water bodies in the country. Most of the water bodies are classified as Class C, usable for fishery, recreation, and supply to manufacturing facilities. In recent years, the government, through "administrative Order No. 34 of the Department of Environment and Natural Resources has given the Pasig River a Class D status due to BOD (Biological Oxygen Demand), TSS (Total Suspended Solids), Phosphates (PO43–) and Coliform values exceeding the water quality criteria for Class C water, which is the lowest possible water classification considered fit for the propagation and growth of fish and other aquatic resources, boating and industrial use."[22]

In 1990, the government declared the Pasig River biologically dead due to the combined effects of industrialization, massive pollution, and urbanization which also threatens the Laguna Bay, the largest freshwater lake in the nation. An estimated 70 percent of the pollution in the Pasig River is caused by residential sewage and the remainder is derived from industry. About 5 million people deposit their untreated wastewater into the river. A study on the composition of pollution in the

Pasig river from 1999 to 2009 reported that "the Pasig River was very polluted, as it failed to meet the DENR standard levels of 5 and 7 mg/L for DO and BOD, respectively. In 1990, 295 tons per day of BOD was discharged via domestic (44%), industrial (45%) and solid (11%) wastes. The highest BOD loading recorded for the Pasig River was in 2009. Parameters, such as DO (dissolved oxygen) BOD (biochemical oxygen demand), TSS (total suspended solids), nitrate-nitrogen (NO_3-N), phosphate (PO_4-P), and oil and grease failed to meet the standards of the DAO 90–34 water quality criteria for Class C waters in almost all quarters of 2009."[23]

Government Water Policy and Laws

Managing, sustaining, and protecting water sources in the face of rapid industrialization, accelerated urbanization, high poverty levels, natural climactic disasters, and climate change is a daunting task for successive national and state governments in the Philippines. Moreover, the country is spread across 7,107 islands. One of the earliest attempts at systematic management of water policy was the Republic Act No. 198, Creation of Provincial Water Utilities (1973) which authorizes the creation of local water districts to operate and administer water supply and wastewater disposal systems in the provincial areas

The most significant water management laws and policies include the following:

National Water Code in 1976, Presidential Decree 1067.

Republic Act No. 8041, National Water Crisis Act of 1995 which addresses issues of water supply, privatization of state-run water facilities, protection and conservation of watersheds, and the waste and pilferage of water.

Presidential Decree No. 1586, Environmental Impact Statement System (1978) governs the conduct of environmental impact assessment studies for all investments undertaken by the government and private sector Presidential Decree No. 424 Creation of the National Water Resource Council.

R. A. No. 9275, Clean Water Act (2004) is a program and regulations for the abatement and management of water pollution from point and nonpoint sources.

Republic Act No. 9003, Ecological Solid Waste Management Act of 2000.

E. O. 192 (1987), sets forth rules and regulations for the control of water, air, and land pollution and effluent standards for water and air quality.

The Clean Water Act–EMB (Environmental Management Bureau) sets forth enforcement for water quality (excluding drinking water) standards and the criteria for water quality management.

Provincial Water Utilities Act of 1973, authorizes the formation of local water districts in provincial centers of the Philippines.

Presidential Decree 424 (1974) authorized the NWRB as the government coordinating body for all water resources development activities.

Water Code of the Philippines of 1976, consolidated all existing legislation relating to ownership, development, utilization, exploitation, and conservation of water resources and authorized the NWRB as the government agency responsible for the implementation of the Water Code.

Republic Act No. 6716 (1989) established mechanisms for the construction of water wells, rainwater collectors, development of springs, and rehabilitation of existing water wells in all barangays in the Philippines.

Republic Act 9275 (2004) "Clean Water Act" provides for a comprehensive water quality management system.

Philippine National Standards for Drinking Water 2007.

Revised Water Usage and Classification/Water Quality Criteria and Revised Effluent Regulations of 1990 (DENR Administrative Order 34 and 35), 1990, DENR Administrative Order 34 amends sections of 1978 NPCC Rules and Regulations and defines beneficial usage and classification of fresh surface and coastal/marine waters; also and coastal waters. Provides effluent standards to all industrial and municipal wastewaters based on the receiving water's classification.

Republic Act No. 9003 "Ecological Solid Waste Management Act" (2000) provides for an ecological solid waste management program, creating the necessary institutional mechanisms and incentives, declaring certain acts prohibited and providing penalties, appropriating funds therefor, and for other purposes.

A Water Development Project Profile

The Pasig River Cleanup Project

On January 6, 1999, a presidential mandate established the PRRC (Pasig River Rehabilitation Commission), tasked with coordinating all

rehabilitation efforts, with the goal of restoring the Pasig River to Class "C" level, that which can sustain life, with BOD (Biological Oxygen Demand) less than 7mg/liter. The 15-year program, with a target date of 2014, did not achieve full results but was a vital step in the right direction. Composed with more powers, the PRRC and thirteen partner government agencies launched the massive environmental cleanup mission to transform the Pasig River into an ecologically viable urban river. The LLDA (Laguna Lake Development Authority) and the EMB (Environmental Management Bureau) have applied strict regulations and a monitoring regime upon factories which deposit pollution into the river. Henceforth, factories and businesses that utilize the Pasig River require an environmental compliance certificate. Every establishment connected to the Pasig River and the Laguna Lake has to submit compliance certification to the agencies responsible for monitoring their waste production. The ADB (Asian Development Bank) provided a financial assistance package of USD 176 million to support river regeneration over the life of the 15-year project.

An important step in infrastructure and environmental planning was the establishment of easements along the riverbanks, from three meters for its tributaries and ten meters for the main river, which have been declared EPAs (environmental protection areas). These have transformed areas into linear public parks. Of the 38 kilometers of both banks of the river, 21 kilometers of linear parks have been developed. Additional initiatives by the PRRC include: construction of a septage treatment plant to serve about 37,000 households in Makati, San Juan, Pateros, Taguig, and Mandaluyong, the purchase of 36 vacuum tankers to transport septage from households, housing, and resettlement with a total of 39 out of the 53 target areas cleared from informal settlers, a total of 6,115 out of the initial target of 10,000 families were relocated between 1999 and 2005, with resettlement sites situated in Taguig, Cavite, and Rizal. Moreover, the Aquino administration pledged P10 billion a year to fund cleanup initiatives for the Pasig River. According to the government, a cleanup of the Pasig River, including all canals leading to it, is possible within six to seven years.

Interview with Lisa Kircher Lumbao

Lisa Kircher Lumbao is a senior environmental expert with over 20 years of professional experience in the Philippines and other Asian countries. She currently works for AECOM International Development as deputy chief of party of the USAID Be Secure Project, which focuses on water

security, climate-change adaptation, and disaster risk reduction in six areas of the Philippines. Previously, she led the USAID Philippine Sanitation Alliance, which worked with cities, the private sector, and water utilities to develop low-cost wastewater treatment and sanitation projects. Ms. Lumbao is certified as a qualified environmental professional by the Institute of Professional Environmental Practice and has a master's degree in environmental management from Yale University.

Describe the current water situation in your country in terms of health, access, and scarcity.
About 92 percent of the Philippine population has access to an improved water source and about 79 percent have access to improved sanitation. However, sewage treatment is limited to about 7 percent of the population and industrial water pollution is not well regulated. Water scarcity is a problem in many areas, with salt water intrusion occurring on Cebu and Iloilo Islands as well as other areas throughout the country. In Manila, groundwater levels are decreasing by 6 to 12 meters per year, putting the aquifers at risk for saltwater intrusion (IDRC).

What are the major waterborne diseases in your country/and or region?
Diarrhea, hepatitis A, typhoid fever, leptospirosis. Waterborne diseases rank #5 among the leading cause of morbidity. Diarrhea/gastroenteritis remains the major cause of child mortality in the 1–4 and 5–9 age brackets.

What are the significant barriers to water quality, health, and access and what is the 10-year and 25-year outlook?
I think the main barrier to improvements in water quality, health, and access is enforcement of existing rules and regulations, primarily due to inadequate government spending, inefficiency, and political pressure and the lack of a strong regulatory agency for water management. If a new regulatory agency can be created in the next five years and the government adequately funds it, the outlook in 10 and 25 years is quite positive.

Describe any groups or minorities that face specific hardships regarding water access and health?
Indigenous people living in remote areas are generally poor and do not have access to improved water supplies. Those living in conflict-affected areas in Mindanao are especially affected.

What is being done to assist these groups at the national or local government level?
The government has several programs to provide funding and technical assistance to local governments that do not have adequate water supply systems. Some donors are providing technical assistance to these programs in two conflict-affected areas.

What policies is the national government developing or conducting to expand water/sanitation health and access?
The Clean Water Act and the NSSMP (National Sewerage and Septage Management Program) are being implemented, but improvement is needed to educate local governments, water utilities, and the general public about the requirements, benefits, and increase enforcement. The NSSMP provides a 40 percent national government subsidy for sewerage projects developed by local governments, but there has been inadequate training and technical assistance provided to develop the projects. The government is currently revising the Philippine Water Code and creating a National Water Resources Management Board Office to improve water resources management and regulation. There are also efforts underway to create a Water Regulatory Commission.

What environmental problems are impacting water quality?
Water pollution is primarily caused by inadequate collection and treatment of domestic wastewater. Most households and buildings use septic tanks, but many of these tanks are not designed properly and not regularly desludged. Many have open bottoms or are not properly sized. If they are desludged, the septage is usually disposed of without proper treatment. Effluent from the septic tanks is not collected and treated. Industrial and agricultural pollution also contribute to water pollution. Many commercial establishments such as hotels, restaurants, and malls also do not have full sewage treatment.

What are the three major steps that could be taken in the future to improve the general water health and access situation?

1. Provide technical assistance to local governments and water utilities to develop septage management programs. The national government is in the process of finalizing a 40 percent subsidy for these projects as part of the NSSMP.

2. Conduct a nationwide promotion campaign on proper hygiene, focusing on hand washing with soap.
3. Reduce open defecation through implementation of community-led total sanitation.

Describe two or three innovative water development or rights projects that are assisting people.
Community-led total sanitation, which is being implemented by Plan International and other groups is reducing open defecation, which causes disease and contaminates water sources.

The DILG (Department of the Interior and Local Government) has been conducting forums on Human Rights-Based Local Water and Sanitation Governance funded by the Millennium Development Goal Achievement Fund (MDG-F). The forums include discussions on corruption, capacity-building, culture, and successful human rights local water governance interventions and tools. The participants also play a life-sized board game on human rights-based local water governance.

A Single Drop for Safe Water is effectively supporting local governments to develop and implement water, sanitation, and hygiene (WASH) programs, build water and sanitation systems, and operate and maintain them in a sustainable manner. The organization also has facilitated the development of a consortium of local groups to provide emergency WASH assistance following natural disasters in the Philippines.

How important are local NGOs and international NGOs in protecting and advancing water rights and development in your country?
Local and international NGOs play an important role in promoting water rights and development, although international groups are often more active.

Describe your own background and water-related work and development.
From 2003 to 2007, I managed a USAID-funded project called LINAW (Local Initiatives for Affordable Wastewater Treatment), which worked with six cities to promote the adoption of low-cost sanitation technology and innovative financing solutions. Project partners financed and built six treatment facilities that provided an estimated 144,400 people with access to improved sanitation and leveraged more than USD 1.3 million in non-US Government funds. From 2007 to 2011, I managed the Philippine Sanitation Alliance project, which was jointly funded by the USAID Global Development Alliance and

USAID/Philippines. The project leveraged more than USD 4.1 million in non-USAID funds by working with 14 local governments and water utilities to develop 46 low-cost wastewater treatment infrastructure projects, numerous policies, implementation arrangements, and effective promotion campaigns. We conducted capacity building and training programs for partners on sanitation issues and designed and managed two Rotary International-USAID grant projects to improve environmental and community development in Metro Manila and to develop sewerage and septage management programs in San Fernando City. I am now working on the USAID-funded Water Security for Resilient Economic Growth and Stability (Be Secure) Project, which seeks to promote good governance and build capacity for long-term water security, improve access to water and wastewater treatment services, and build more resilient communities. The project started in July 2013 and had five focal areas; Leyte Province was added as a sixth area to allow for a long-term focus on Typhoon Yolanda (Haiyan) recovery. The project aims to assist 1.2 million people gain access to improved drinking water, and 400,000 others gain access to improved sanitation facilities.

CHAPTER EIGHT

Thailand: A Struggle against Climate-Change Flooding

Country Overview

Thailand is a rapidly developing country that is impeded by income inequality and a high ratio of rural poverty. A large proportion of the population live in the rural areas many of which are underdeveloped such as Issan and the northern regions. Marginalization is a common development issue in Thailand most noticeably with the northern hill tribes who have faced decades of underdevelopment. Half-a-million northern hill tribe persons, who are an indigenous population, have been denied citizenship by the Thai government which precludes them from essential services such as health care and education. Although Thailand has abundant water resources, water quality and access is inconsistent. Many impoverished rural areas lack a consistent and safe water supply. Numerous Thai rivers have been found to contain 30–60 times more pathogens, heavy metals, and poisons than safety regulations allow. Although Thailand is making progress on the rural development and water quality standards, the competition for development and profit often conflicts with sustainable and healthy development practices. For instance, the Map Ta Phut Industrial Estate in Rayong province comprises 117 industrial plants including 45 petrochemical factories, 8 coal fired power plants, 12 chemical fertilizer factories, and 2 oil refineries. Water sampling from the Map Ta Phut area reveal high levels of toxins that are a health and environmental threat to over 25,000 local residents.

Thailand has a tropical climate marked by the southwest monsoon which causes substantial rainfall from May to October and the northeast monsoon which is characterized by cool and dry weather from October to February. The weather pattern in March and April is normally distinguished by thunderstorms. Thailand is the world's leading rice exporter yet faces serious water challenges due to global warming, flooding, and inconsistent irrigation sources. In general, agriculture consumes 70 percent of water resources. Thus threats to water sources are a major development concern for Thailand that will affect many areas of society and specifically the agricultural sector which employs 38 percent of the workforce. "Most farmers are poor and have been facing economic and financial risk due to climate change and water related emergencies. More than 65% of agricultural areas do not have good access to water. The Northeast receives water shortages, resource scarcity and a relatively harsh climate which often result in floods and droughts."[1]

Major health, economic, and water indicators

Human Development Index (HDI) for Thailand, 2014: 89
Population, 2014: 67.01 million
Gross national income (GNI), 2012: USD 5128.00
Life expectancy 2012: female: 77.8
male: 71.1
Improved rural water source, 2012: 95 percent
Population percentage with access to improved sanitation, 2013: 96 percent
global average: 72 percent
Rural population, 2012: 65.6 percent
Poverty index, 2012: 13.2 percent
Homeless population, 2014: 0.427 percent
Carbon dioxide emissions per capita (tons), 2014: 4.45

The main source of drinking water for most Thai people is derived from surface and ground water. Untreated domestic sewage, industrial pollutants, and hazardous wastes are increasingly deposited into waterways. Approximately one-third of surface water is of poor quality due to contaminants such as pollution and sewage. Generally, the lowest-quality surface water is found in the north-central and southern areas. An estimated 80 percent of the urban population has access to treated piped drinking water and this figure is projected to increase to 91 percent by 2017 according to government plans. The rural population has on average 70 percent access to piped water, rainwater containers,

and tube wells for drinking water. Yet tube wells, which are prevalent in the countryside, carry an inherent risk of leakage, erosion, and contamination.

Bangkok: City Water Profile

Bangkok is the capital city of Thailand and a leading metropolis in Southeast Asia. In 2014, it had a total metropolitan population of approximately 14 million representing 22 percent of the national total. With rapid population growth, Bangkok is witnessing increasing water quality issues related to pollution, overuse, infrastructure quality, access, and chemical and sewage dumping in water sources. Moreover, the famed Chao Phraya River, the major waterway and water source for Bangkok, is increasingly threatened by substantial chemical and sewage pollutants. The city is situated on the Chao Phraya River, which is the primary drinking water source for residents. Bangkok rests a mere 0.5 to 1.5 m above sea level which leads to constant flooding problems which have had devastating effects for centuries. This natural geographic situation leaves the city increasingly vulnerable to climate change and the associated risk of flooding that is predicted. The city is replete with canals and waterways which are generally heavily polluted. The canals are a major depository for pollution and raw sewage which eventually reach the Chao Phraya River. In Bangkok, about 1.5 million cubic meters of wastewater is released into waterways everyday and only 23 percent of Bangkok's population is connected to sewer systems.[2] Flooding is a common occurrence in the wet season. This causes considerable health and transportation problems for thousands of city residents.

The Chao Phraya and the Maeklong rivers are the source of drinking water for Bangkok residents. The Chao Phraya River flows from the north of Thailand to the Gulf of Thailand in a southerly direction. The river runs through Bangkok where it receives wastewater from industrial and domestic sources. The MWA (Metropolitan Waterworks Authority), a state-owned enterprise, has four water treatment plants, Bang- khen, Mahasawat, Samsen, and Thonburi, that extract raw water from these raw water sources. The MWA operates 14 water distribution pumping stations in the Greater Bangkok region which provide tap water to city residents. It also operates more than 30 pumping stations and a distribution grid of 24,000 km of pipelines. The network of canals (Klongs) in Bangkok which reach over 300 km in total are a unique characteristic of the city yet a source of substantial pollution

and flooding. The BMA (Bangkok Metropolitan Administration) area covers the delta plain of the Chao Phraya River with a total area of approximately 1,560 square kilometers.

The existing household water treatment capacity in Bangkok serves only about 2 percent of the population. Normally the wastewater from most households is deposited to septic tanks, cesspools, and then discharged into storm water drains. The domestic effluent accounts for 75 percent of the pollutants discharged into the Chao Praya River (BOD load), while factories account for 25 percent. Nonindustrial sources and household effluents account for over 54 percent of the pollution, whereas restaurants, markets, hospitals, hotels, and dormitories are responsible for 46 percent of the pollution.[3] In Thailand, there are 76,000 companies which are registered as polluting factories. Still only 10 percent of these factories have wastewater treatment and the largest number of them are concentrated in the Bangkok region. Although large factories are required to install water treatment facilities, this does not apply for many medium and small-sized plants which normally discharge their effluents straight to rivers and water bodies.[4] According to a government environment report, "the canals are presently highly polluted due to direct discharge of wastewater throughout the city area. Although large buildings are required to have some form of wastewater treatment, and also small private houses are required to have at least septic tanks to receive toilet wastes, domestic wastewater are mostly discharged to public drains without treatment. The septic tanks generally have outlets to public drains or canals."[5] "Biochemical oxygen demand (BOD) is a measure of water quality, while pristine streams exhibit high levels of BOD, low BOD levels indicate degraded water quality. The water in Bangkok's canals is so polluted that levels of BOD in Bangkok's canals are equivalent to BOD levels in sewage."[6] Bangkok is the major population and commercial center of Thailand. In general, developing countries are witnessing a long term and substantial migration shift from the rural communities to the urban centers. This pattern is also evident in Thailand as more and more citizens gravitate to Bangkok. In terms of water security, the challenge for municipal authorities is to improve the water and sanitation systems and health standards in the face of increasing population growth and user demand.

The Klong Toey Slum

Another major challenge facing Thailand is the provision of adequate socioeconomic development and water security in the slums of Bangkok.

The infamous Klong Toey slum of Bangkok has an estimated population of 100,000. The Klong Toey slum is one of Thailand's 5,500 slum communities. Approximately 20 percent of Bangkok's residents live in illegal squatter settlements. Many inhabitants of Klong Toey have migrated from impoverished rural communities in the northeast of Thailand, which is a chronically underdeveloped region of Thailand, or have migrated from neighboring developing countries. The slums are notorious for unsafe water and sanitation and high rates of chronic illness. In Klong Toey, the average household earns just 50 percent of the national average and approximately 30 percent of the average Bangkok household income. Many of the slum dwellings do not have a safe source of water nor adequate sanitation systems. Moreover issues of overcrowding, crime, and pollution are commonplace.

Health and Human Rights Challenges

Thailand has experienced tremendous improvement in social, health, and economic indicators over the past four decades. Yet health and development challenges still remain. Poverty and underdevelopment are still prevalent in the northeast, scattered rural communities, and the slums of major cities. Approximately 60 percent of Thailand's poor live in the northeast. The risk of major infectious disease in the country is still very high. "Food or waterborne diseases include bacterial diarrhea. Vector borne diseases include dengue fever, malaria, and Japanese encephalitis, which affects the central nervous system."[7] Cholera has been observed in the country. Cholera is an acute diarrheal disease caused by *Vibrio cholerae* bacteria. It is transmitted through contaminated food and water. "More than 50 per cent of sub-basin population in six Mekong River Basin (MRB) sub-basins (representing 20 per cent of the total MRB population) lack access to safe drinking water. The situation is distinctly better (20 per cent of the population lacks access to safe drinking water) in sub-basins predominantly within Thailand."[8]

According to the Thai MWA, domestic water supply coverage is 47 percent in the provinces for households. Water provision for domestic use by farming households is about 56 percent from piped schemes, 37 percent from wells, and 6 percent from rivers. Approximately 62 percent of the rural households use water from unprotected sources that include rainfall collection, rivers, canals, and ponds. In the rural areas, village communes have a prominent role in the operation of water

systems. Potable water supplies are commonly provided by two agencies: the MWA (Metropolitan Waterworks Authority) and the PWA (Provincial Waterworks Authority). The MWA is responsible for the production and distribution of potable water in the Bangkok metropolitan region. Conversely, the PWA is responsible for all the provinces in Thailand. The PWA handles a range of important functions including water source development, pumping, treatment, storage, and distribution facilities from all the urban and the rural communities in the provinces. "Serving some 10 million inhabitants in the provinces of Bangkok, Nonthaburi and Samut Prakarn, the MWA has a daily water production capacity of 5.5 million cu meters. Water supplies are sourced from the Chao Phraya River (70% from the Bhumibol and Sirikit dams), and 30% from the Mae Klong Dam with a loss ratio of 26% which is significantly lower than the 40% registered a decade ago."[9] The extremely high rate of rural water collection for household use from unprotected sources is a cause for concern and a contributor to waterborne diseases in rural Thailand. Major health risks posed by unprotected and contaminated water sources include bacteria (bacteria, viruses, and parasites are constant threats to unprotected drinking waters sources), nitrates, herbicides, pesticides, and raw sewage. *E coli* bacteria is found in human sewage or animal feces and a major health risk. Many rural residents use tube wells which can become contaminated with bacteria, pollution, chemicals, and human waste if not properly maintained and monitored. Adverse health symptoms from drinking contaminated water may include gastrointestinal and stomach illnesses such as vomiting and diarrhea.

Primary drinking water sources in Thailand include rivers and lakes. Thus increasing evidence of serious water pollution in the Chao Phraya River and other drinking water sources are a health risk to the population. Water quality is a function of DO (dissolved oxygen), the capacity of microorganisms to consume oxygen (BOD), ammonia (NH_3) concentration, and the existence of coliform bacteria. Low levels of DO and/or high BOD, NH_3, and coliform will be an indication of inferior water quality. In Thailand, over 50 percent of the rivers have acceptable water quality yet about 30 percent are seriously polluted. Environmental concerns are clearly evident in "the lower Thajeen River (low DO and high NH_3), Lam Thakong of Moon River (high BOD), and Songkla Lake (high bacteria and NH_3). Maeklong and the middle and lower parts of the Chao Phraya, Bang Pakong, Nakornnayok, and Rayong Rivers are experiencing rapid degradation in water quality. In Maeklong, this year, polluted water has destroyed the sea shell

plantations for the cost of more than ten thousand million THB. Small and medium fishery folk are now suffering for the loss and in the process of negotiation for compensation, as the polluted water was proved to be drained from the flooding in Bangkok and nearby areas."[10]

The United Nations Special Rapporteur on the human right to safe drinking water and sanitation, Catarina de Albuquerque, visited Thailand in 2013 and was critical of the country's progress on a number of important water and sanitation benchmarks, including the limitation of pollution in major waterways. According to de Albuquerque, "rivers and other sources of water are being increasingly polluted by the discharge of untreated human waste. I was shocked by the very poor management, disposal and treatment of human waste, which may be one of the major causes of the increasing diarrhea morbidity rate in Thailand in spite of the high basic sanitation coverage that has been achieved."[11]

The Thai Ministry of Public Health reports that the rate of access to safe water is 25 percent in the rural areas and 40 percent in the urban areas. In addition, pollution control at the urban and the rural level is a serious deficiency that causes considerable health and environmental damage. Moreover, Thailand has experienced an ongoing urban–rural development gap that is quite substantial in some regions. The northeast region of Thailand suffers chronic poverty and the Thai Government has been criticized for years over the marginalization and severe poverty facing the northern hill tribes of whom an estimated 450,000 are denied citizenship by the Thai government and have their mobility restricted. As de Albuquerque noted:

> The contrast between people who have access to water and sanitation in modern and formal zones in cities and those who suffer from the lack of access to these basic services and have been left behind, including informal settlements and hill tribe communities, was striking. The people who live in the shadows of Thai society suffer not only from the lack of access to water and sanitation but also from stigma and denial of dignity and privacy. I am deeply concerned that no State entity is in charge of monitoring and ensuring the quality of water inside the household. I call on the Government of Thailand to establish strong accountability mechanisms to ensure full compliance by all, including the private sector, with the human rights to safe drinking water and sanitation. Proper regulation in the water and sanitation sectors is fundamental.[12]

In the 2004–2024 period, water demand is forecasted to increase by 35 percent to 77,000 Mm^3 in 2024 (1 Mm^3=264 MG of water). It is therefore incumbent upon the Thai government to ensure water security at both the urban and the rural level, with increasing focus upon the rural water infrastructure development. Moreover, water treatment and sanitation, which is still rudimentary in many areas, must be substantially upgraded to be more accessible for a greater number of citizens. Only 21 percent of community wastewater produced daily is treated, increasing the risk of diseases.[13] The government plan for polluted water treatment in 2025 is projected at 16.1 Mm^3 per day while treatment levels in 2012 were at 1.2 Mm^3 per day.[14]

Environmental Challenges

Thailand is beset by numerous environmental challenges the most serious of which are flooding and drought. Recent disasters include the 2001 flood and landslide at Ban Nam Kor, Petchaboon which led to 126 fatalities; the 2004 flash flood and mud slide in Ramad district that struck numerous villages affecting 5,990 people; the 2006 torrential rains that led to flash floods and mudslides in five areas of the country and the north causing devastation to 300,000 people with 80 fatalities and damage estimated at 250 million THB; and the devastating 2011 floods which hit Bangkok and affected much of the country. The floods were caused by Tropical Storm Nock-ten. The disaster affected 13.6 million people and caused 815 fatalities. Moreover, 65 of Thailand's 77 provinces were declared flood disaster zones by the Government.

Climate Change

Climate experts predict that Thailand will experience an increase in flooding and more pronounced drought due to the effects of climate change. Thailand has many low-lying areas and is vulnerable to excessive flooding which has become a natural climate pattern. Thailand is an agricultural nation and highly dependent on rice production as the worlds' leading rice exporter. Thus changes in climate, flooding, and precipitation levels have a profound influence upon irrigation, economic development, land ecology, income, farm employment, and health. According to a recent report, "Modelled WEAP results also align with the IPCC (2012)–International Panel on Climate Change

report on managing risks of extreme events, in that the key projections and implications for Southeast Asia under the A2 emission scenario will likely be to increase warm days and frequency of heat waves, with the possibility of more frequent and intense precipitation days. Extreme temperatures by the mid-century will increase in frequency from 1 event every 20 years to 1 every 1.5 years, and extreme precipitation by mid-century will increase in frequency from 1 event every 20 years to 1 every 10 years. Thus, there is high confidence that extreme events could affect water management systems."[15] A study by the OECD on global warming estimated that 5.1 million people in Bangkok may be exposed to coastal flooding by 2070, the seventh highest among the world's port cities. Currently 900,000 city residents are affected by flooding.[16]

In Thailand, flooding is caused by tropical disturbances or typhoons. Flash floods commonly occur in the highland areas. From 2000 to 2010, over 10,000 villages in the country were affected by high-risk floods. A recent report on the interrelationship between flooding and climate change has dire predictions for Thailand and other affected states, "Twelve countries contain 90% of the total 148 million of people exposed, notably in China (21%), India (11%), Bangladesh (12%), USA (9%), Vietnam (9%), Japan (5%), Thailand (3%), and as well as Myanmar (3%). The monetary value of assets exposed to a 1 in 100 year extreme water level, globally is estimated to be US$3,000 billion today; corresponding to around 5% of global GDP in 2005. In the future, the total value of assets exposed is projected to grow rapidly, reaching US $35,000 billion by the 2070s; more than ten times current levels and rising to roughly 9% of projected global GDP in this period. Nationally, the exposure analysis reveals that 90% of the total estimated 2070s asset exposure across the 136 cities is concentrated in only eight countries China, USA, India, Japan, Netherlands, Thailand, Vietnam and Bangladesh."[17] For a country striving to attain higher levels of economic stability and social equality, particularly after the devastating effects of the Asian economic crisis of the 1990s, Thailand faces a myriad of health, economic, and environmental crises due to the protracted effects of flooding and climate change.

Climate change is blamed for both extremes of drought and flooding. In Thailand, water shortages that are evident in nonirrigated areas are caused by climate change. This has resulted in insufficient water supply for domestic and agricultural production in the dry season. In 2008, the population suffered from severe drought as over ten million people in the rural agricultural region were affected. From 1990

to 1993, rainfall was below customary levels which resulted in water shortages. Yet the following two-year period witnessed excessive rainfall patterns that caused the most damaging flooding in Thai history. These extreme weather patterns are a great concern to the national government because of the devastation, infrastructure damage, economic losses, and health crises they impose upon the population. Moreover, in 2005, 11 million people were hit by water shortages. The impacts of climate change on rice production in Thailand has been analyzed by numerous researchers. According to one study, the estimated yield of Thai rice is expected to decline about 18 percent in the 2020s because of alterations in temperature and rainfall cycle and through changes in soil quality, pests, and diseases as the impacts of climate change.[18] Results from the MWBP (Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme) research indicate that many rice growers in the basin area faced the risk of losing paddy fields from floods and droughts due to climate change.[19]

Official statistics show that the country's major reservoirs have dropped to 57–60 percent capacity near the levels of 2005 when one of Thailand's most devastating droughts hit 71 provinces and caused approximately THB 8 billion in damage. The drought in the Chao Phraya River basin's Nakhon Sawan, Chai Nat, and Lop Buri provinces from October 2014 to March 2015, affected 75,700 rai–nearly 50 percent of which was rice fields and caused damage to 25,196 tons of rice worth THB 212 million. The eight provinces that were declared disaster zones due to the drought included Nakhon Ratchasima, Chaiyaphum, Lop Buri, Maha Sarakham, Nakhon Sawan, Sukhothai, Sakon Nakhon, and Buri Ram. Drought impacted areas covered 2,091 villages in 30 districts of the eight provinces.

About 42 percent of the Thai labor force is engaged in the agricultural sector yet government action on sustainable irrigation systems has not kept pace with demand. Thailand's 2015 drought crisis expanded into the central, northeastern, and southern regions. In Chainat province, for example, the declining water levels of numerous rivers forced fish breeders to abandon their aquaculture after more than 2,000 rai of fish farms dried up. Fish farmers had no choice but to find other jobs to supplement their modest incomes. The impact of the 2015 drought also had adverse effects upon aquaculture and economic development in Kalasin province. Moreover, an estimated 36,000 rice farmers in Thailand's central region were compelled to accept substitute jobs offered by the government due to the limitation imposed upon them against planting off-season crops. The drought will cut the 2015

off-season crop by over 30 percent. According to the Agriculture Ministry estimates, approximately 160,000 hectares or 1.3 percent of Thailand's total rice farmland will be affected by drought. In 2012, only 29.57 million rai, or 9.2 percent of Thailand's landmass was irrigated. This figure represents a slight increase on the 28.35 million rai in 2009. The Royal Irrigation Department has announced plans to expand the irrigated area by 6 million rai by 2020.

The destructive 2015 drought that began in November 2014 hit more than 160,000 hectares (395,000 acres) of second harvest rice farmland alone. The Kasikorn Research Centre estimated losses at approximately THB 5.6 billion (USD 171 million). Thailand's Department of Disaster Prevention and Mitigation (DDPM) reported in March 2015 that 28 provinces were declared disaster regions and that 63,000 families had been affected and 112,000 ha (277,000 acres) of farmland destroyed. In November 2014, the Thai government warned farmers not to cultivate a second rice crop due to low water levels. The RID (Royal Irrigation Department) reported that 64 percent of the water reserved for the dry season had already been depleted. The RID also stated that the water levels at four of Thailand's major dams, Bhumipol, Sirikit, Kwae Noi, and Pasakcholasit, situated in the low elevation areas of the Chao Praya River, contained only about 6.2 billion cubic meters (219 billion cubic feet) of water, just over 50 percent of their total combined capacity. The Thai cabinet approved a comprehensive Integrated Drought Management Plan in 2015 of THB 7.8 billion (USD 240 million) to support the provision of movable water tanks and to install water pumps in affected areas. The five-year plan, in addition to addressing the 2015 drought, will focus upon the nationwide water shortage crisis. The plan has four critical components:

(1) prevention and response; (2) preparedness for disasters; (3) crisis management; and (4) post disaster management.

Thailand is extremely vulnerable to flooding and this climate phenomenon will inevitably become worse as the effects of climate change become more pronounced. In July 2011, triggered by the landfall of tropical storm Nock-ten, flooding spread across the provinces of northern, northeastern, and central Thailand and along the Mekong and Chao Phraya river basins. In October, floodwaters reached the mouth of the Chao Phraya and saturated parts of Bangkok. Flooding continued unabated in many regions in January 2012 and resulted in a total of 815 deaths and 13.6 million people affected. According to government

data, of 77 provinces, 65 were declared flood disaster zones, and over 20,000 square kilometers of farmland were damaged. The World Bank calculated the destruction from the 2011 flooding episode at a staggering USD 45 billion in economic damages and losses.

The Chao Phraya River

The Chao Phraya River originates in the northern mountains of the country and flows from the north to the south through the central plains into the Gulf of Thailand. It covers an area of 162,000 square kilometres, almost one third of the entire nation. The Chao Phraya river basin, which is the largest and the most significant in Thailand, is facing increasing water pollution and water shortages. The river basin covers 30 percent of Thailand's land area, is home to 40 percent of Thailand's population, employs 78 percent of the national labor force, and contributes 68 percent of its GDP (Gross Domestic Product). The total population of the Chao Phraya basin in 2015 was 25 million. The Chao Phraya Basin has witnessed a greater frequency of both flooding and drought in the past three decades. Climate change along with deforestation are two of the principle factors scientists believe are contributing to this phenomenon.

The Chao Phraya river basin is the largest and most significant basin in Thailand. It is also characterized by increasingly high levels of water withdrawal and demand. The basin though is experiencing ongoing and protracted water shortages. Due to the fact that a high population base depends upon the basin for their livelihood, adverse climate patterns and effects are of considerable concern to area residents and the government. The 1996 NESDB study on a strategy for water resources management in the Chao Phraya river basin confirms the problem. "The water shortage of the Lower Chao Phraya depends very much on the combined available water stored by the Bhumibol and Sirikit dams and on total rainfall in the Northern region. The shortage of water will worsen in future, since water demand continues to increase both upstream and downstream while the total water supply remains the same or even decreases due to deforestation. During the 1999 dry season, paddy plantation was reduced because of the water shortage."[20]

The effects of pollution, both chemical and sewerage, is having a devastating effect on the river. "Pollution, land subsidence, widespread flooding, and seepage of saline water into freshwater aquifers pervade a city in which only 2% of Bangkok's population is connected to the

city's antiquated sewer network. The lower sections of the Chao Praya River are no longer able to support life. With its population doubling every 15 years, ground water depletion has resulted in seepage of the sea water into water tables under the centre of the city."[21] Studies conducted in 1997 by the Thailand Environmental Institute for the Pollution Control Department assessed water quality in the Chao Phraya River. The analysis pointed to a toxic environmental assessment for the river and its ecology after decades of chronic pollution. "There was evidence of heavy pollution in both the Chao Phraya and Tha Chin Rivers. The Chao Phraya River exhibited serious organic and bacterial pollution that was a threat to many species of aquatic life. Water pollution is caused by the discharge of agricultural wastes (pesticides, fertilizer, pork farm effluent, etc.), sewer outlets and industries. It has an adverse impact on domestic uses along waterways, on human health, aquatic fauna and flora and on several agricultural activities. Organic load, with subsequent low levels of dissolved oxygen in the water is mostly caused by domestic waste and by waste water discharged from prawn, duck and pig farms."[22] As the paramount waterway for Thailand, the Chao Phraya River is essential to commerce, agriculture, transportation, and as a source of drinking water for millions of citizens in and around Bangkok. The Thai government faces critical challenges with respect to protecting and enhancing the river quality and functions.

Government Water Policy and Laws

Thailand water policies are formulated by three agencies, which are responsible for different areas of the water system. The Department of Water Resources is responsible for national water policy. Groundwater policy comes under the Department of Groundwater Resources. The Royal Irrigation Department is responsible for agricultural water policy. A Water Regulatory Commission is planned as an independent agency to regulate the water sector. The MWA and the PWA supply piped water in the urban and the suburban areas. The Department of Public Works assists 117 municipalities in producing and distributing piped water.

The new Thai Constitution of 1997 encouraged public engagement in natural resource management and conservation. The water sector is one area where main stakeholders are actively involved. In the area of water resource management, the royal Thai government's

plan for water management includes eight priorities. They involve a combination of policies to prevent a repeat of the devastating 2011 floods. The most significant financial commitment is directed toward expenditure on construction of floodways and the establishment of water retention areas. These represent about 80 percent of the estimated budget of approximately USD 10 billion. Thai government priorities include:

Restoration and conservation of forests and ecosystem.
Management of major water reservoirs and formulation of water management plans.
Restoration and efficiency improvement of current and planned physical structures.
An information warehouse and forecasting/disaster warning system.
A preparation plan for emergency situations in specific areas.
Selecting water retention areas and recovery measures.
Improving water management institutions.
Create understanding, acceptance, and participation for large-scale flood management from all stakeholders.

The MWA is committed to a number of important initiatives including: significant pipe replacement projects to support an increase in water pressure consistent with the policy target for 2017; increase water pressure up to 10 meters for reducing electricity costs in water pumping and moderating water loss down to 20 percent; strengthening the stability in the production system, and conducting a study for a new source of raw water in the Upper Chao Phraya River Basin in Chainat to support water usage for the next 100 years.

Major government laws and policies in recent years include the following:

1989 National Water Resources Committee established.
2000 National Water Policy was formulated.
2002 The Department of Water Resources (DWR) was established within the new Ministry of Natural Resources and Environment (MONRE).
2005 Twenty-five River Basin Committees (RBC) were established.
2006 The government created the National Committee on Climate.
2007 National Water Resources Strategic Plan.
2007 The Government Climate Change Office Coordination was established in the Ministry of Natural Resources and Environment.

2008 The Government released the National Strategy on Climate Change for 2008–2012.

2013 The Thai Government and cabinet passed a resolution in February 2013 designating the Ministry of the Interior, Department of Disaster Prevention and Mitigation, Ministry of Agriculture and Cooperatives, and relevant agencies to operate under a single command system by 2P and 2R measures (Prevention, Preparation, Response, and Recovery). The designated ministers and departments are responsible for drought management in 29 provinces and to collaborate with the Ministry of Agriculture on artificial rain initiatives and to work on issues of water distribution, well digging, and canal drainage.

Water Development Project Profile

Royal Rainmaking Project

In order to reduce the devastation of drought, Thailand's King Bhumibol Adulyadej put emphasis upon a strategy to increase rainfall. Launched in 1955, the royal rainmaking project now utilizes planes that seed clouds with salt in order to unlock the moisture within, creating "royal rain." When the country faced severe droughts in 2002, King Bhumibol Adulyadej sought a patent for his "cloud-firing" technique to make artificial rain. The king was subsequently granted a European patent. The process involves firing silver iodide particles into clouds so that water vapor will gather around the particles and fall as rain. The king's technique uses two aircraft at different altitudes to seed warm and cold clouds, allowing for a more exact rainfall location. China, Indonesia, and South Africa have used the technology. The technology has been in use for 50 years. The artificial rain is expensive to generate yet can be significant in saving crops that are adversely affected by drought. The project has proved successful since the first experiment in 1969. In 1971, the government established the Artificial Rainmaking Research and Development Project within the Ministry of Agriculture and Cooperatives. Since demand for artificial rain has increased over the years, the Artificial Rainmaking Research and Development Project has been continuously upgraded and developed. Australia utilized the technology in 2013 to combat drought in Queensland.

Thailand has had a difficult history with drought. In 2015, Thailand was once again confronted with drought in 8 of the 76 provinces.

The Thai Interior Ministry allocated approximately 6.8 billion THB (USD 208.65 million) to alleviate drought conditions, an increase from 430 million THB (USD 13.19 million) in 2014. Drought has a devastating effect upon the agricultural sector and primarily rice production. The northeastern region, also known as the Khorat plateau, is situated 90–200 meters above sea level. Approximately 30 percent of the land area and almost 50 percent of the rice area are located in this region. The incidence of soil erosion and drought during the dry season can be severe.

The northeastern region produces long grain and glutinous rice. The central region is a heavily cultivated area. Approximately 75 percent of the dry-season rice grown under irrigated conditions is located in the central region. The northern region has 33 percent of the total land area of Thailand and comprises 20 percent of the country's total rice area. The southern region comprises 14 percent of the country's land area and 6 percent of overall rice production. As the world's leading rice exporter and a primary agricultural country, Thailand is highly vulnerable to changing climate patterns and the effects of drought, flooding, wind erosion, extreme heat, and salt water intrusion. Over the past 100 years, approximately 10 million people in Thailand have been seriously affected by drought. In the 2013 drought, 56 provinces, 588 districts, 3,958 subdistricts, and 37,820 villages were adversely impacted. The areas included 20 provinces in the northeast, 18 provinces in the north, 7 provinces in the south and east, and 4 provinces in the central. The 2015 drought also had devastating effects. Consequently, the royal rainmaking project, initiated by the king of Thailand, is a significant initiative in a country beset by drought, particularly in the northern regions.

The technology of rainmaking science is a weather modification system that is utilized to enhance or redistribute rain in order to alleviate drought effects. Since the early phase of royal rainmaking, in 1999, His Majesty discovered a new technique named "Super Sandwich." This technique is the step of the royal rain operation that combines the techniques of warm clouds (7,000–10,000 feet) and cold clouds (up to 20,000 feet) simultaneously to increase the amount and extent of rainfall. Today, the Bureau of Royal Rainmaking and Agricultural Aviation has been involved with the design and implementation of a series of experiments and royal rainmaking operations in the country. "The Eastern Region of Thailand is characterized by short mountain ranges alternating with small basins of short rivers which drain into the Gulf of Thailand. A major economic commodity in this region

is fruit, which is a well-known export, such as Durian, Mangosteen, and Rambuton. The cloud seeding operation in the Eastern region is unique and different from the other regions. The operation flight pattern, type and quantity of chemical substances, duration of operation were examined based on typical climate data. The results of the operation would increase the natural rainfall indicated by weather radar evaluation and local people network's report."[23]

(Source: Prapaporn Srisathidtham and Wassana Wongrat, 2010)

Interview with Dr. Ammarin Daranpob, Thailand Water Management

Dr. Daranpob joined a scientific task force at Coastal Hydroscience Analysis, Modeling and Predictive Simulations Laboratory (CHAMPS Lab) to study the Ecological Effects of Sea Level Rise in the Northern Gulf of Mexico, a grant funded by the US NOAA (National Oceanic and Atmospheric Administration). He codeveloped "Metropolitan Water Availability Index" funded by the US-EPA.

In 2011, he received the Professional Award from the American Society of Photogrammetry and Remote Sensing. Remote sensing technologies were used to assess environmental impacts on water quality in forested watersheds, urbanized areas, and estuaries.

Describe the current water situation in your country in terms of health, access, and scarcity.

Based on my personal point of view, most people in Thailand have access to water but with quality differences.

Very small villages in the remote areas might have access to untreated surface water or groundwater wells. Water for agriculture is distributed by a central government agency called the RID (Royal Irrigation Department). There are still thousands of agricultural acres that are only rain fed.

What policies is the national government developing or conducting to expand water and sanitation health and access?

The government has given priority to sufficiency of water supply for all consumers. Thus the administration has declared that it will solve the water shortage problem endorsed by the cabinet meeting on May 17, 2005. The Ministry of Natural Resources and Environment along

with related agencies shall include water projects and budgets into the development plans. The meeting recognized the issue of severe water supply shortage. The goal is to provide an adequate water supply, construction of water supply systems, and water distribution systems to villages where there is no plumbing and villages with existing water systems.

What environmental problems are impacting water quality?
The main environmental problems are from industry, nonpoint sources are from agricultural areas, inappropriate and illegal waste disposal and landfills, soil erosion, unmanaged storm water.

Interview with Dr. Apichart Anukulamphal

Dr. Apichart Anukulamphal is the president of the Thailand Water Resources Association and former chairman, Water Management Advisory Committee, government of Thailand.

In Thailand, what environmental problems are impacting water quality?
The environmental problems which are impacting water quality are legislation, law enforcement, and public awareness. First, in Thailand there are adequate legislations dealing with environmental issues, but may lack some specific ones when it comes to protecting the very source of water crucial for the water needs of the rural communities. For example, we have legislation for the control of point source pollution but still lag behind in the nonpoint source pollution from agricultural and urban areas. Second, though there is legislation in place, sometimes the influence becomes a problem due to insufficient manpower, lax enforcement, or conflict of interest, and so on. Third, public awareness is still lacking in tackling water quality issues, as the general public still adopts an indifferent attitude to many of the water quality issues.

How important are the local NGOs and the international NGOs in protecting and advancing water rights and development in your country?
The role of the local NGOs and the international NGOs in protecting and advancing water rights and development in Thailand can be characterized as a mix. For the international NGOs, their roles are more of supporting local NGOs and providing knowledge. However, they might be involved in big cases concerning water issues. On the other

hand, the local NGOs get involved from the local level to the national level. At the local level, they produce some good cases in protecting the resources and helping the local population to solve and advance water agenda. On the national level, the results are mixed, for some time due to a lack of information and understanding, the fight to protect or raise critical challenges on some projects were based on misinformation and sometimes based on emotion. Thus it is important to distinguish between various NGOs with respect to their commitment, and their capability to apprehend proper knowledge in addressing the sometimes complicated water issues.

Describe your background and water-related work and development.
As to my personal background dealing with water-related work and development, my background is engineering by training and starting with teaching at the university as well as conducting research. Later, I was given an opportunity in policy formulation and national planning which broadened my personal perspective and thinking about water. The word sustainable development is far from reality in the developing countries, because for the sake of national development, the planners, policy makers are bent on exploitation of resources to generate GDP, which produces short-term results but leads to long-term damage and creates more social problems especially in terms of equity and wealth sharing.

Describe the major priorities in your own work and/or NGO work you are associated with for the next five years.
As the president of an NGO, the priorities in promoting and advancing a water development agenda are:

(i) Awareness raising for the grassroots-level stakeholders to understand the real water issues which may affect their livelihood
(ii) Advocate sufficiency utilization of water in line with the sufficiency economy, for there is just not enough water to meet the endless need if one cannot rationalize the best and productive use of water.
(iii) To facilitate a change of the mindset of decision makers and engineers to have new concepts about water-related development and approaches. Some current policy and engineering approaches/practices have been proven to cause more harm than benefit to the long-term well-being of the population.

(iv) To promote networking of water and non water-related professionals in conducting studies and sharing of experiences in order to come up with more adaptive thinking toward sustaining development which preserves the integrity of nature for future generations.

(v) To establish a regional water academy for raising awareness, training, experience sharing, and joint research to address the cross-sectoral issues of water for better management. To better serve the basic needs of the population with the ultimate objective of attaining sustainability.

CHAPTER NINE

Vietnam: A Struggle against Climate-Change Drought

Country Overview

Vietnam is a rapidly developing country that is challenged in some regions by a wide income inequality and high incidents of rural poverty. A large proportion of the population live in the rural areas where water quality and water access are often inadequate. Incidents of disease and health complications are consistently higher in the rural areas compared to the urban settings in developing countries. There is evidence of growing pollution in the coastal, ground, and surface waters of Vietnam. Downstream sections of many rivers provide evidence of poor water quality. Pollution and sewage are contaminating many freshwater sources. From 2009 to 2013, six million cases of waterborne diseases were registered by health authorities for a combined cost of 400 billion VND. Malaria, typhoid, dysentery, and cholera pose consistent health threats to the population. The country is divided into 64 provinces with a total area of 331,052 square kilometers. Hanoi is the capital city of Vietnam. Climate change will clearly have an impact in terms of flooding because 70 percent of the country rests at 500 meters above sea level or less. Experts have widely predicted that flooding will be a major effect of climate change and lowland nations such as Vietnam are particularly vulnerable to the range of negative development implications that will occur. Flooding in lowland areas will negatively affect crops, food prices, employment, economic standards, health, disease ratios, and a host of other critical development issues. Vietnam is also characterized by notable weather variation with hot, humid, and rainy

climate zones. Central Vietnam is affected by severe storms and hurricanes and massive waves from the South China Sea.

The Vietnamese constitution has three specific provisions that address environmental security. Article 29 states: "All State offices, armed forces units, economic establishments, social organizations and every citizen have to observe State regulations on the appropriate utilization of natural resources and on environmental protection. All acts resulting in depletion and destruction of the environment are strictly prohibited." Under Article 112, the government is obligated to protect the environment. Article 17 under Chapter II regarding the economic system, states that the land, forests, rivers and lakes, water sources, underground natural resources, resources in the territorial waters, on the continental shelf and in the air space, capital funds and properties invested by the State in enterprises and projects in the various branches and fields of the economy, culture, social life, science and technology, foreign affairs, national security, defense, and other property defined by law as belonging to the State fall under the ownership of the entire people.

Major health, economic, and water indicators

Human Development Index (HDI) for Vietnam, 2014: 121
Population, 2014: 91.68
Gross national income (GNI), 2012: USD 1343.00
Life expectancy 2012: female: 77.4
male: 73.4
Improved rural water source, 2012: 94 percent
2010: 90 percent
Population percentage with access to improved sanitation, 2013: 76 percent
global average: 72 percent
Rural population, 2012: 68.3 percent
Poverty index, 2012: 17.2 percent
Homeless population, 2014: 2.031 percent
Carbon dioxide emissions per capita (tons), 2014: 1.73

Vietnam has abundant groundwater resources, however, the national challenge rests with the provision of clean, safe water evenly across the population and the construction and operation of safe sanitation systems to avoid dangerous contamination of water sources. From 1945 to 2000, per capita water volume decreased from 14,520 per capita to 4,840 per capita. An urban–rural development gap and income inequality between the rural and the urban inhabitants is evident. Groundwater supply has

been estimated at 60 billion cubic meters per year. Rapid urbanization and growth, particularly in the two major cities of Hanoi and Ho Chi Minh City, are placing significant strains on water supply and delivery. A large share of the lakes, rivers, and canals near the urban centers reveal evidence of worsening pollution and contamination levels. The dumping of chemicals in waterways that eventually reach human use is becoming pronounced and a growing health concern. The country is susceptible to a range of natural disasters including floods, typhoons, storms, and drought. These natural phenomenon impose severe economic strains upon the country. Moreover, the effects of climate change will be an additional burden for the country to address. The impact of climate change will be challenging, in varying degrees of intensity, upon health, flood control, economic, and water security issues. Water withdrawal for irrigation is estimated at 68 percent. Climate change is expected to impose additional stresses upon food irrigation which in turn will influence food prices and availability for a growing population. According to the UN Joint Monitoring Programme for Water and Sanitation, only 23 percent of Vietnamese had a tap in their home in 2010.[1] Moreover, 59 percent of households in the urban areas and only 8 percent in the rural areas and 200 of 650 district towns in the country had no piped water at all.[2]

It is clear that a number of significant water issues face the country. One important area for improvement is the need to strengthen water resource management. As noted, Vietnam does not suffer from a lack of water but from weak infrastructure and delivery systems. Management due diligence would also extend to the maintenance of pollution control systems which are vital to maintain the health requirements of water sources. Current practices do not go far enough in regulating, monitoring, and reversing the disturbing level of chemicals, toxins, and sewage deposited daily into major waterways. Moreover, contamination of soil and lands also exposes water sources to unhealthy levels of pollution and disease. The ecological sustainability of rivers, lakes, waterways, aquifers, and canals is another weak spot that government policymakers need to address. At present, pollution control is not a high priority in government environmental policy and regulation. There was an increase of 38 percent from 1990 to 2010 in the number of people using an improved water source from 57 percent of the population to 95 percent. Major gains were recorded among the rural population whose access increased from 49 percent to 93 percent in the same period. Sanitation, closely linked to water health and development, shows improvement. Over the 1990–2010 period,

there was a 39 percent increase in the number of people utilizing an improved source of sanitation. Yet the term "improved water source" and "improved sanitation source" can be misleading and obscure gaps and quality deficiencies. Moreover, 25 percent of the population still lack access to a safe and healthy sanitation system. This development gap contributes to major disease and health burdens.

Ho Chi Minh City: City Water Profile

HCMC (Ho Chi Minh City) is located in southern Vietnam and is the largest city in the country. It is situated 50 kilometers from the East Sea and has an estimated metropolitan population of 7.5 million. HCMC covers an area of 2,095 square miles. The Doi Moi (Renovation Policy) instituted by the government in 1987 has been responsible for rapid economic growth and the emergence of hundreds of factories in the city. Industrial, business, residential, and recreational demand upon water outpaces supply. Moreover, the rapid industrialization of HCMC in just four decades has contributed to substantial chemical and sewage pollution of waterways and the integral Dong Nai–Sai Gon Rivers. This development, combined with steady population growth, has strained city water supplies and added a pollution and wastewater crisis that is a major environmental and health challenge.

The current total daily water use demand for domestic and industrial use in HCMC was 1.75 million square meters in 2006 and projected to be 3.6 million square meters in 2020. Vietnam is one of the largest contract manufacturing centers in the world and growth is continuing at a steady pace. The industrial zone in Bien Hoa is upstream from HCMC. It has been estimated that 200,000 cubic meters per day of wastewater is dumped into the Dong Nai–Sai Gon rivers from industrial zones. Moreover, the rivers are the major drinking water source for the residents of HCMC. The Dong Nai River has a minimum flow of approximately 100 cubic meters per second and originates from the central highlands of Vietnam and flows through Dong Nai and HCMC. In early April 2000, more than 50 tons of fish were killed in an upstream feeder of the Tri An Reservoir in the upper reach of the Dong Nai River. The main suspects for the pollution were two agro-industrial plants, the La Nga Sugar Cane Company and the Mauri La Nga Food Fermentation Joint Venture Company.[3]

"In Truong Tho, Thu Duc district, residents near the industrial zone have suffered from the problem of severe creek and groundwater

pollution, which results from the discharge from a number of sources. Each day, about 7,000 cubic meters of untreated wastewater from 10 factories are discharged into the receiving creek, which flow on to waterways in the residential area before eventually reaching the Saigon River. In 2001 it was reported that companies such as Phuoc Long Textile company, the seafood processing company Cofidec, and the Mai Tan Paper Company discharged about 1500 cubic meters, 90 cubic meters, and 200 cubic meters of untreated wastewater respectively into the water environment daily."[4]

Data provided by the Water Supply Company indicates that approximately 461,000 cubic meters of wastewater discharged into the canal systems daily is derived from 680 factories and 22,562 small manufacturing enterprises operating in the city in 1997. Most of these wastewater sources do not have wastewater treatment facilities. "Wastewater samples collected from some of the food-processing plants (numbering about 100) situated in and around the city area were analyzed by the Geographic and Geological Society of Ho Chi Minh City, and the results showed that the BOD (biological oxygen demand) levels ranged from 300 to 2800 mg/l which is 3 to 28 times above the Vietnamese standard."[5] The daily projected volume of wastewater is 2,100,000 cubic meters, yet currently only a minimal quantity of wastewater is being treated at Binh Hung Hoa wastewater treatment plant which has a capacity of 30,000 cubic meters per day. These statistics indicate clearly the level of infrastructure deficiency that the Vietnamese government must address urgently.

Heavy pollution from wastewater, sewage, and chemicals into the Sai Gon–Dong Nai rivers affects a total population of 8.3 million including 19 districts in HCMC. According to a recent environmental assessment: "there were about 1 million m^3 of domestic wastewater containing 375 tons of TSS, 244 tons of BOD, 456 tons of COD, 15 tons of N-ammonia, 8 tons of phosphorous, and 46 tons of oil and grease discharged directly into rivers without treatment. The Sai Gon River received 76.2 % of the total volume of domestic wastewater and the highest BOD amount of 243 tons BOD/day and 69% of the total oil and grease while the Dong Nai received River received 15% of the total volume of domestic wastewater and about 18% of total pollution loads."[6] The Dong Thanh dump site, with an area of 40 hectares, located on the outskirts of HCMC, is a stark example of the soil and water degradation that contaminates the city water. The site is not environmentally secured thus wastewater seeps into the soil which leads to underground water pollution. Residents often dig wells to reach

water but are unable to do so because of its unsafe quality. Moreover, the leakage from the landfill into nearby areas has caused damage to the livelihood and quality of life of the local population. Wastewater from the waste storage lakes (about 200,000 cubic meters with average chemical oxygen demand concentration of about 40,000–50,000 milligrams per liter) is not treated to environmental standards and seeps into the underground water deposits.

In Vietnam, household drinking water sources are divided into four categories. Approximately 19 percent of households receive their water supply from companies; 0.5 percent of households purchase water from vendors; 26 percent of households purchase hauled water, and 54 percent of households acquire water from drilled water sources and wells. "About 84% of rural households boil water before drinking. The Red River Delta, North Central Coast and the low-lying provinces of the Northeast are regions with the highest rates. In the North West, South Central Coast, Central Highlands and South East, from 20% to 25% of households do not boil water before drinking. About 35% of households in the Mekong do not boil water before drinking."[7] Results from a GSO survey indicate that regular filtration or chemical disinfection of drinking water is practiced by only a small fraction of the population and some households routinely utilize aluminum sulphate to remove the particulate matter and help remove microbial pathogens.[8]

It is evident that the Vietnamese government and HCMC have three specific and urgent priorities with respect to water quality. First, rampant and unchecked chemical pollution from the massive industrial parks into the waterways and river systems must be reduced and reversed. Second, the chronic dumping of sewage from HCMC into the Sai Gon–Dong Nai rivers must be addressed urgently to forestall long-term health, ecological, and development crises. Third, the facilities and infrastructure in HCMC for piped water must be improved along with access to sanitation systems.

Health and Human Rights Challenges

Waterborne disease affects millions of Vietnamese each year. The subsidiary costs of waterborne disease are significant and impose huge burdens upon individuals and families as well as provincial and national development outcomes. Drinking water is fundamental to health and life. The absence of safe and secure water sources place enormous health and development burdens upon the country. Vietnam has

achieved progress in drinking water access yet problems remain with episodes of waterborne disease and contamination in many rural areas and parts of major cities. Studies conducted by the Vietnam Institute of Biotechnology revealed widespread contamination of municipal tap water including high levels of *E coli*. Some tap water samples were also found to contain ammonia at levels 6–18 times higher than the safe levels and arsenic levels were determined to be three times higher than the standards set by the WHO. Hanoi, the major northern city of Vietnam with a burgeoning population of 6.1 million, has a water contamination problem. Government assessments have determined groundwater with ammonium levels that are 5–10 times the acceptable health limits.

The disease risk profile for Vietnam is rated as "very high" for infectious diseases and reveals significant health issues particularly in the rural areas and the slums of major cities. Food or waterborne diseases include bacterial diarrhea, hepatitis A, and typhoid fever. Vector-borne diseases include dengue fever, malaria, and Japanese encephalitis, which affects the central nervous system.[9] The transmission season is May to October with the highest rate of infections occurring in Hanoi and the surrounding areas. Since typhoid is spread through contaminated water, there is a risk of contracting the disease most notably in the rural areas. Poor and vulnerable groups in areas of high water pollution and contamination are most at risk.

A Sanitation Crisis

There is increasing evidence of dangerous levels of pollution in Vietnam's surface, ground, and coastal waters. Although the quality of upstream river waters is generally good, downstream sections of major rivers reveal poor water quality and most of the lakes and canals in the urban areas are fast becoming sewage sinks. Total pollution of water resources from household sources indicates that annually, approximately 2.3 million tons of feces, 46 million cubic meters of urine and 610 million cubic meters of gray water are released into inland water resources annually in Vietnam. "Data from 2005 reveals the type and extent (tons/year) and (m^3/year) (m^3) of pollution in water sources. Feces Urine Gray water: Red River Delta 493,831 / 9,876,613; North East 256,185 / 5,123,690; North West 70,235 / 1,404,695; North Central Coast 290,722 / 5,814,442; South Central Coast 192,988 / 3,859,766; Central Highlands 130,276 / 2,605,518; South East 368,472 / 7,369,437; Mekong River Delta 472,700 / 9,453,993. Moreover, water pollution caused by cottage or trade villages is now a very critical

problem in Vietnam. The impact on surface water results from the inadequate collection of waste water and solids from food processing, wooden fine arts production and paper recycling."[10]

In addition to human waste, the urban areas and the industrial zones in Vietnam contribute an estimated 20,000 tons of solid waste every day of which only 60 percent is collected and disposed of. In the urban areas, sewage and contaminate often find their way into landfills, which can ultimately seep into domestic water sources such as aquifers and wells. Another source of pollution and waste is cottage/trade villages of which there are an estimated 1,450. Approximately 67 percent of the commercially focused villages are located in the Red River Delta; 20 percent in the central area; 12 percent in the southern area. The economic activities in the various commercial villages include agricultural product processing, weaving, and dyeing, fine arts, recycling, and construction materials. Collectively these villages generate huge volumes of solid waste which often get deposited into land and waterways.

It is clear that Vietnam has not invested adequate resources into a sanitation and sewage infrastructure nor given the issue the urgency demanded for national health and development. Sewage and drainage coverage in the urban areas has been calculated at 40–50 percent (from 0 percent in some small towns to 70 percent in the larger cities). In the last ten years, the Vietnamese government and a multitude of donors have concentrated on improving water access and supply which is clearly vital. Yet important subsidiary issues of sanitation and sewage disposal have been neglected. This national neglect has resulted in enormous health, economic, and development burdens. Moreover, the government MDG goal on sanitation was not met in 2015. According to one study, "poor sanitation causes considerable financial and economic losses in Vietnam. Financial losses—reflecting expenditure or income losses resulting from poor sanitation average 0.5% of annual GDP, while overall population welfare losses average 1.3% of GDP. The majority of economic losses are shared between health (34%) and water resources (37%), and environment (15%).The estimated overall annual economic losses from poor sanitation are US$780 million. The costs on environment, tourism, and other welfare impacts contribute 15%, 9% and 6% to overall economic losses, respectively."[11]

In addition, there are costs associated with inadequate and unsafe sanitation that extend beyond the obvious realities. One routinely applied international measurement for capturing an accurate profile of disease burden is DALY (disability-adjusted life year). "The estimated

cases and deaths per year from selected diseases which are attributable to poor sanitation reveal that diarrhea has the most number of cases at 7.05 million. Diarrhea is also the main cause of death from poor sanitation and hygiene, accounting for 4,576 deaths per year. Malnutrition-related diseases, in particular ALRI (acute lower respiratory infection), account for an estimated 1,475 deaths per year, followed by malaria with 631 deaths per year. Diarrhea diseases contribute the largest proportion of health costs. The second is malnutrition-related diseases."[12]

Arsenic Contamination in Water

Arsenic poisoning in the major waterways of Vietnam has been well documented. Indications are that the Red River and Mekong Delta have levels that exceed WHO standards by up to 40 percent in some places. One report suggests that 10 million people living along the Red River and 500,000–l million people in the Mekong Delta are at risk of chronic arsenic poisoning.[13] The three routes for human arsenic exposure are ingestion, inhalation, and dermal. Ingestion is the most common route of exposure through drinking water and food. The inhalation of inorganic arsenic has been determined to cause increased risk of lung cancer. Chronic and higher exposure to arsenic can also contribute to skin, bladder, kidney, and other types of cancer. A 2014 report on arsenic contamination concluded the following:

> Arsenic in drinking water in Vietnam is a severe public health risk; 13.5% of the population receive drinking water from tube wells with documented levels of arsenic that in some cases exceed acceptable health levels; a survey of 12 provinces with 12,461 well-water samples from the Red River Basin provinces, including Ha Nam, Nam Dinh, Ha Tay, Hung Yen, and Hai Duong revealed arsenic contamination from mild to severe; an examination of 300 tube well samples from water utilized by 150 households in one village found that 40% of the adults had daily arsenic exposure exceeding the TDI (Tolerable Daily Intake) at 1ug/kg/day.[14]

People in Vietnam are dependent on groundwater as a drinking water source. Tube wells are commonly used in the country yet evidence suggests that many of these wells have levels of arsenic that are unsafe for human consumption. Although many households have resorted to using filters to screen out arsenic from water obtained from wells, these devices only have on average an 80 percent reduction rate. Moreover,

the filtered water may still contain arsenic levels that are dangerous for human consumption. Vietnam is classified as an arsenic-affected groundwater country. Hanoi, the capital city, has elevated levels of arsenic contamination.

According to researchers, "several million people in the Red River Delta are exposed to a risk of arsenic poisoning yet few disease symptoms have been diagnosed thus far. This could be attributed to the fact that in Vietnam, arsenic contaminated groundwater has only been used as drinking water for the past 7–10 years and the early manifestation of arsenicosis is difficult to diagnose and depends on the awareness of local doctors."[15] Other reports suggest that people develop symptoms, such as cancers, from arsenic poisoning after a period of 15–20 years. Given the wide body of evidence available related to arsenic contamination of drinking water sources, Vietnam is potentially facing a health crisis that could impact millions of citizens.

Environmental Challenges

Climate Change

Vietnam is one of the nations in the world that will be impacted substantially by climate change. Increased flooding, rising sea levels, damaged agricultural lands, affected growing seasons, and rising temperatures are certainties for the future. The country is already prone to flooding and has wide areas of lowland terrain. The IPCC has predicted that a rising sea level will impact Vietnam. Many urban and rural areas in Vietnam are threatened by flooding. In the Global Climate Risk Index ranking, Vietnam is placed fifth and with severe stress due to climate change. As of 2010, 4 million people per year were exposed to floods. These figures are expected to rise. Agriculture, forestry, and fisheries, are integral to the economy and national development and collectively comprised 21 percent of the GDP (gross domestic product) in 2009. About 70 percent of the population live in the rural areas and 48 percent depend upon agriculture for their livelihoods. Vietnam is currently the second highest rice exporter in the world. In 2010, the country produced 39.9 million tons of paddy, and exported 6.83 million tons of milled rice. Thailand and Vietnam together account for 50 percent of the world rice trade. Consequently, climate change will have an enormous and potentially negative impact upon food security. Already, 14 percent of the population is undernourished and 20 percent

of the children. The United Nations has worked with the Vietnamese government on climate-change issues and to situate effective policies into the National Socioeconomic Development Plan under the leadership of the Ministry of Planning and Investment. Moreover, the ADB (Asian Development Bank) has estimated that climate-change impacts could seriously affect Vietnamese rice and coffee production by 2020.

In 2010, drought severely affected the country. Since September 2009, there were low rainfall patterns across most of Vietnam. The Red River in the north and Mekong Delta, were dramatically hit by low water levels and drought issues. The Vietnamese Ministry of Agriculture and Rural Development announced in March 2010 that 100,000 hectares in the delta were under threat. Drought conditions in Vietnam will be exacerbated by climate change. Over 50 percent of Vietnam's 44 million labor force are engaged in agriculture. Conditions of drought and water shortages have a devastating ripple effect upon the entire society and economy though it clearly impacts the farmers and their communities the hardest. In 2010, the Red River, a critical source of sustenance for millions of Vietnamese, was at its lowest level in more than 100 years. The drought transformed sections of the usually abundant river into parched sand dunes. In June 2010, the government announced USD 5.3 million in funding for drought relief in the northern city of Haiphong and 11 northern and central provinces. In 2015, Vietnam experienced another severe drought episode. About 2,500 out of nearly 20,000 hectares of crops in the central province of Khanh Hoa were affected by the drought which is the worst in ten years. The water volume of rivers in Khanh Hoa fell by as much as 80 percent because of the low rainfall levels in 2014. A number of reservoirs held only 25–50 percent of their capacity while others virtually dried up. Further examples of the destructive effects of the drought were found in the Central Highlands. In the province of Dak Lak, 6,000 hectares of rice and 23,000 hectares of coffee were hit by extreme conditions and damages from the drought. The municipal Department of Agriculture and Rural Development estimated the damages at VND 980 billion.

Pollution

Rapid economic development brings mixed benefits for Vietnam. Economic growth and rising living standards are welcome features of development. However, the negative effects of this development include well-documented health problems, ecological damage, chemical contamination of water and soil, and the depositing of tons of sewage into

the environment each year. One of the major concerns raised in recent years involves the pollution of rivers and river basins which are highly sensitive to environmental contaminants. The ecological balance of these systems is delicate as witnessed by the chronic problem of water-borne disease affecting millions of Vietnamese citizens, the destruction of many fish species due to toxic waters, and the degradation of plant life and vegetation.

In Vietnam there are 13 main rivers and nine river basins. These river systems and basins like much of the natural environment have been affected by years of chronic pollution. "The surface water of the Cau River is polluted by organic pollutants, suspended solids and oil waste. In the section passing through Bac Kan province, the river is heavily polluted with BOD5 and suspended solids. The river section from Vat Bridge to Pha Lai has been heavily polluted with organic substances and the level of pollution becomes far higher than the permitted standard. This organic pollution was caused by waste water from domestic, urban and tourism activities as well as oil pollutants from industrial waste. In the case of the Nhue River, COD and BOD5 levels are four times the acceptable standard and domestic waste water contributes a destructive 56% of the river total volume."[16] Evidence suggests that approximately 98 percent of 200 rivers and lakes do not meet water quality standards.[17] Vietnam has 200 registered industrial zones that do not operate waste treatment systems and the discharge is equal to 1 million cubic metres of untreated sewage per day.[18]

The Sai Gon River

The mighty Sai Gon River, the livelihood for HCMC and the neighbouring communities, is in danger of becoming a floating river of sewage and chemical toxins. It supplies water for irrigation and a water supply for HCMC and the Tay Ninh province reaching upward of 20 million people. The 256 kilometer Sai Gon River is a tributary of the Dong Nai, which leads to the South China Sea. Scientific analysis reveals that domestic wastewater has severe pollution contributing 62.2 percent of total sewage flowing into the river. This factor, combined with severe industrial pollution, have jeopardized the ecological and health conditions of the Sai Gon River.

The Sai Gon–Dong Nai rivers are vital to economic development for 12 provinces and four economic zones: Binh Duong, Ba Ria Vung, Tau, and HCMC. These zones include 54 percent of the industrial productivity and 60 percent of exporting activity of the country. The

zones have 47 industrial parks and 72 projected industrial zones for the year 2020.

> Only 14 of 47 existing industrial parks have wastewater treatment systems. High volumes of pollution from 57,000 small-scale industries are also discharged into the rivers. There are 116 residential areas in the Sai Gon–Dong Nai River Basin belonging to four cities, 19 districts and 85 towns. Most residential areas do not have domestic waste water treatment and this results in an increase of organic pollutants and more risks of water borne diseases related to bacteria and viruses. The Sai Gon River received 76.2 % of the total volume of domestic wastewater and the highest BOD amount of 243 tons BOD/day and 69% of the oil and grease.[19]

The industrial parks and factories are crowded along the river banks which collectively discharge about 100,000 cubic meters of wastewater per day. Animal farms alone are contaminating the river with about 2,600 cubic meters of waste each day. Moreover, it is estimated that less than 20 percent of household wastewater from HCMC is collected and treated, with the remainder discharged into the river.

In 2013, the provincial Environment Protection Bureau fined 555 enterprises a total of VND 12.6 billion (USD 583,000) for violating environmental regulations. One of the challenges that environmentalists and responsible government departments face is the lax environmental and enforcement standards. The government itself is partially to blame for permitting a culture of pollution to continue unchecked and unchallenged for decades. Test results in the province show that pollution has increased. Moreover, the monetary level of fines is not sufficient in many cases to deter industrial polluters.

Government Water Policy and Laws

With the substantial rise in pollution, both from sewage and chemical dumping in waterways and the crisis of adequate sanitation coverage, it is evident that Vietnamese policymakers have pressing challenges on several fronts to address.

Major legislative and policy advances include the following:

1995 Agreement on Cooperation for the Sustainable Development of Mekong River Basin.

1998 Vietnam National Water Resources Law (NWRL).
2002 Ministry of National Resources and Environment established.
2003 Law on Land.
2003 Law on Fishery and Aquaculture.
2004 National strategy for the Environment 2004–2020.
2004 Water Utilities Administration established.
2005 Law on Environmental Protection.
2006 National Water Resources Strategy 2006–2020.
2007 National Strategy on Disaster Prevention.
2007 Urban Water Supply and Sanitation Reform.
2008 National Target Program on Climate Change Mitigation and Adaption.

Water Development Project Profile

Hearts for Hue, in collaboration with private sector and government partners, launched and completed "The Clean Water Pipeline Installation" project in 2014 for Kenh Tac village, in Hue province. The scenic village of Kenh Tac is located 35 kilometers from the center of Hue. The village is one of the poorest villages in the Vinh Thai commune. It has a population of 319 people in 74 households of which there are 95 children. Farming and fishing form the main economic activities for the village. Survey work indicated that the river water was severely polluted with attendant health issues affecting the villagers. Children, the elderly, and others with compromised immune systems were particularly affected. Dermatological problems were common and gynecological issues were frequently diagnosed in women. The primary cause of these conditions was determined to be bacterial contamination in the river and the alum in groundwater which is used for washing clothing and for bathing. Before the installation of the pipeline, the villagers had no access to clean water. Water was retrieved from the local river and from rainwater collected. For the people in the Vinh Thai commune, clean water for the inhabitants in Kenh Tac Village is an ongoing problem. Due to inadequate local government funding for the clean water system installed, the 319 villagers themselves must continue to use water every day that is not clean. Their aspiration is to have clean water to improve health and life.

After receiving corporate sponsorship, and working with the NGO, Hearts for Hue and the Peoples Committee of Vinh Thai Commune, a 1,000 meter main water pipe system was installed in the village and

water pipe systems into each of the 74 village homes. A local water supply company in Thua Thien Hue province conducted training on maintaining the water pipe system. The immediate results are significant in terms of health improvement. The flow of clean, piped water has ensured a rise in general health and reduction of illness due to waterborne infection and bacterial contamination. Moreover, family and individual time savings are considerable because people no longer have to venture to the river to collect water or devote time to water collection.

Interview with Khanh Truong, Chairperson, Hearts for Hue, Vietnam

Hearts for Hue is a Vietnamese NGO **e**stablished under the permit issued by Thua Thien Hue Provincial Government People's Committee, dated May 23, 2007.

Describe the current water situation in your country in terms of health, access, and scarcity.

In Vietnam, the proportion of the rural population using clean water reaches 84 percent. This proportion is different between the regions, as follows: it is 80 percent in the northern mountainous region, north central is 75 percent, and highlands is 80 percent. These are areas with a high proportion of poor and ethnic minorities. According to Decision No. 366/QD-TTg of the prime minister: By 2015, 85 percent of the rural population will have clean water. According to statistics from the WHO (World Health Organization) in 2008, 80 percent of illnesses in developing countries are related to water and sanitation, environmental contamination, and each year more than 20,000 Vietnamese people die due to contaminated water and unsanitary conditions.

In Thua Thien Hue, according to statistics from its water company, in 2013 the percentage of people using clean water all over the province was 73.5 percent, but it was only 60.1 percent of people using clean water in the rural areas. The number of cases of water-related disease declined significantly, in which there were a considerable decrease in the number of cases of diarrhea, dysentery and cholera by 45 percent (9218/17044), 65.3 percent (2501/6822), and 95.2 percent (2/42) respectively. The increasing rate of people using clean water means that the number of cases of disease has decreased.

What are the major waterborne diseases in your country/and or region?
In Vietnam and in the Thua Thien Hue province in particular, the diseases related to lack of clean water and sanitation are:

Gastrointestinal diseases
Diseases of the eyes, skin, gynecology

What are the significant barriers to water health and access?
There are many causes affecting the access of clean water and health for the people:

Lack of funds for installing the clean water supply systems in the rural areas;

Awareness of farmers in water use and protection of natural water is still limited;

Natural water sources such as rivers, lakes, wells are often contaminated which affects water quality and human health.

Describe any groups or minorities that face specific hardships regarding water access and health?
In Thua Thien Hue, the rural groups and the ethnic minority groups are two groups facing specific hardships regarding water access and health. According to Thua Thien Hue Company, 26 percent of the population (300,000 inhabitants) in the rural areas and some wards of Hue city do not access clean water.

These are areas with a high proportion of poor, their main activities are farming, forestry, and aquatic activities.

The natural conditions are not favorable; low growth, poor technical infrastructure; lack of resource development; poverty is slowly improving; the quality of education and human resources is low.

Ethnic minorities in Phuc loc village and woman in a rural area-Kenh tac face hardships.

What is being done to assist these groups at the national or local government level?
With the financial support of foreign organizations such as ADB, INGO, the Vietnam government has been improving remarkably in providing clean water to the people in Vietnam, particularly for the rural residents and the ethnic minorities. In 2008, the Thua Thien Hue Company received an ABD grant of 1.35 million from the Seureca

Company (France) to upgrade and expand the clean water supply system to the rural areas in 2011–2015. Another project that is aimed at development progress by 2030 has a budget of USD 104 million, in which there is 81.54 million of ADB's OCR (Ordinary Capital Resources) and 22.86 million of local funds. The repayment period is 25 years.

What policies is the national government developing or conducting to expand water/sanitation health and access?
Decision No. 104/2000/QD-TTg on approving the National Strategy on clean water and sanitation in the rural areas in 2020. Objectives are:

(a) Target 2020: All rural residents will have clean water to use with at least 60 liters/person/day, using sanitary latrines, good personal hygiene, and clean sanitation in villages;
(b) Target 2020: 85 percent of the rural population to use safe water quantity of 60 liters/person/day, 70 percent of families and the rural population using improved sanitation facilities, and implementation of good hygiene practices by individuals.

What policies would you like to see the national government introduce to improve water/sanitation access, quality, and health?
Support building of water systems for the rural and the ethnic minorities.

Describe the particular challenges facing vulnerable and minority children with respect to water access and health.
The vulnerable and minority children are direct victims of water scarcity with the following challenges:

Health issue: Gastrointestinal diseases and worm diseases cause malnutrition in children and affect the physical development of children.
Environment issue: Pollution always occurs in the areas without clean water, and children are the most vulnerable subjects in the community.
Educational environment: According to our latest survey in one rural village named Kenh tac in Thua Thien Hue, the lack of clean water impacted badly the education quality and educational environment of the kindergarten and primary school.

What environmental problems are impacting water quality?
Living and industrial waste has impacted water quality.
Residue of pesticides and chemical fertilizers used in farming pollutes water quality.
Climate change affects water quality.

What are the three major steps that could be taken in the future to improve the general water health and access situation?

1. Mobilizing financial resources to implement the decision No. 366/QD-TTg of the prime minister on providing clean water for all people in the country.
2. The local authorities should have a specific strategy for the development and expansion of water supply systems for the rural areas and apply new technologies for treating contaminated water.
3. Raising public awareness especially among the rural people and ethnic minorities on the protection of water resources and conserving water use.

How important are the local NGOs and the international NGOs in protecting and advancing water rights and development in your country?
The local NGOs and INGOs have been playing an important role in poverty alleviation in Vietnam, especially on the clean water issue. The contribution of local NGOs and INGO are as follows:

Provide financial support for the construction of water supply systems with high technology for the residents in the urban and the rural areas.
Raise awareness among the people about water rights, water resource protection, diseases related to polluted water, and workshops and training at all levels.
Work together with the Vietnamese government on water program development.

Describe your own background and water-related work and development.
Thua Thien Hue is a province in central Vietnam with a population of 1,115,523 inhabitants. Clean water for the rural residents is a big challenge for the local authorities as there are a lot of rural villages, resettlements, and mountainous areas where there is no access to clean water. The local people therefore have to use water from the local river and from the rain for cooking, bathing, and washing their clothes and other

daily activities. This is the main cause of the diseases of eyes, skin, and gynecology in these areas. Realizing the difficulties of local people, Hearts For Hue has started the clean water program for boat people in Phu Binh (in 2008) and Vy da (in 2010) resettlement areas with the financial support of DOVE Fund (USA) and providing clean water for over 500 people. In 2014, we constructed a successful clean water system to supply water for 320 people in Kenh tac village, Vinh Thai commune, Phu vang district, Thua Thien Hue province, Vietnam.

Describe the importance of improved sanitation systems for health and water safety in your country or province.

Sanitation and safe water play an important role in the quality of life and development of the community. A good sanitation system and safe water will create a comfortable living environment and it will help to improve the residents' health and help to prevent eye and skin diseases and gynecology-related problems. Besides, the child's body will be developed perfectly and they will be better able to develop the country in the future.

Describe the major priorities in your own work and/or NGO work you are associated with for the next five years.

Our plan in the five coming years is to focus on providing clean water for the rural areas in the Thua Thien Hue province. According to the statistics from the Thua Thien Hue Water Company, there are 32 wards and the rural communities (about 300,000 people) who do not access clean water and they are in need of help. We hope that with the support of foreign aid and the contribution of local funds, we will be able to have:

(1) Clean water program for the rural areas:
   Supplying clean water for 10 villages (5,000 people) in the rural areas.
   Training on water protection and water rights for over 5,000 people in the rural areas.
(2) Microfinance program:
   Supporting loans for 2,000 poor women in resettlement areas and 1,000 persons with disabilities in Thua Thien Hue, Vietnam
(3) Volunteer program:
   Organizing 50 volunteers groups who come from ASEAN countries to improve the education quality for the rural kindergartens and schools in Thua Thien Hue.

Conclusion: Innovation and Water Security

The growing global recognition among citizens, governments, and civil society that water is a precious and fragile resource is a hopeful sign. Through crisis often comes opportunity and ingenuity and these are the precise developments urgently required today to address water scarcity and related issues. Moreover, the expected global population surge from 7.1 billion (2015) to 9.7 billion (2050) will place considerable strains upon available water resources. There are an estimated 800 million people today without an adequate water supply and this number is expected to reach approximately 50 percent of global population by 2050.

The United Nations has followed up the much heralded MDGs (Millennium Development Goals) with a new set of goals designed to continue progress on imperative global development. These new development targets are designated SDG (Sustainable Development Goals). The SDGs include:

Many of these laudable goals are related to water security and water rights. However, the most significant one is Goal 6 with a stated purpose to: "Ensure availability and sustainable management of water and sanitation for all." The vital components of Goal 6 include:

Goal 1	End poverty in all its forms everywhere
Goal 2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
Goal 3	Ensure healthy lives and promote well-being for all at all ages
Goal 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5	Achieve gender equality and empower all women and girls
Goal 6	Ensure availability and sustainable management of water and sanitation for all
Goal 7	Ensure access to affordable, reliable, sustainable, and modern energy for all
Goal 8	Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all

Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
Goal 10	Reduce inequality within and among countries
Goal 11	Make cities and human settlements inclusive, safe, resilient, and sustainable
Goal 12	Ensure sustainable consumption and production patterns
Goal 13	Take urgent action to combat climate change and its impacts
Goal 14	Conserve and sustainably use the oceans, seas, and marine resources for sustainable development
Goal 15	Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss
Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels
Goal 17	Strengthen the means of implementation and revitalize the global partnership for sustainable development

6.1 by 2030 achieve universal and equitable access to safe and affordable drinking water for all.

6.2 by 2030 achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

6.3 by 2030 improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and increasing recycling and safe reuse by x percent globally. (This target percentage has not yet been defined)

6.4 by 2030 substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity.

6.5 by 2030 implement integrated water resources management at all levels, including through trans-boundary cooperation as appropriate.

6.6 by 2020 protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

6.a by 2030 expand international cooperation and capacity-building support to developing countries in water and sanitation related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies.

6.b support and strengthen the participation of local communities for improving water and sanitation management.[1]

Each of the governments and societies examined herein have proposed and in many instances activated progressive and responsible policies and laws to address water security and health. As long as these steps are linked to effective enforcement and follow-up, progress can be realized. Moreover, these important steps will also require sustained effort and dedication in the face of growing threats from climate change, population stress, and pollution.

In the important area of water security, it is clear that innovative measures, the renewed application of ancient water conservation practises, and cutting edge research are vital pathways to progress. Three approaches, namely RWH (rainwater harvesting), desalinization, and cloud seeding are demonstrating hopeful signs in addressing increasing water security concerns.

Rainwater Harvesting

RWH is an ancient and effective eco-friendly technique that has been utilized for over 3,500 years. It has recorded use in early Greek, Chinese, Roman, and Arab civilizations. It is utilized to provide water for drinking as well as irrigation. Its application is particularly suitable to developing countries where technology and capital can be limited. The harvesting of rainwater is a simple process that involves the collection of water from the various surfaces upon which rainwater falls. Water can be collected from building rooftops, including houses, and simple dwellings, and stored in rainwater tanks. The basic essentials include: eaves or gutters, down pipes, rainwater drains, filters, and disinfectants. Eaves or rudimentary funnels can collect the water and provide a run off tube that flows into barrels or storage tanks. The issue of sediment on the roof area or bacteria in the water can be solved by the use of filters and disinfectants.

Basic filtration systems can utilize screen filters, paper filters, and carbon or charcoal filters. A reliable and safe system will depend upon more than one filter device. Often a 50 micron size filter or equivalent screen is utilized to remove larger particles such as dirt. This would normally be followed by the use of additional 20 and 10 level micron filters then smaller filters at the 10 and 5 micron level such that particles are progressively screened out. Disinfection of the water source is an

important step in RWH to eliminate pathogens and unsafe microorganisms. Typical disinfection includes chlorine, ozonation, UV (ultraviolet) light, and membrane filtration.

A recent study on RWH extolled its many benefits. The study noted that, "Increased scarcity of water in most dry areas has resulted in renewed interest and revival in the technique. Other contributing factors towards the urge/drive to harvest rain water especially in rural; areas are the increased use of small scale water supply for productive and economic purposes, decreased in quality and quantity of ground water, absence of piped water supply systems, the flexibility and adaptability of rain water harvesting technology and the increase in the availability of affordable tanks. In Asia, RWH started around the 9th or 10th century when rain water was collected from roof tops. In Thailand, 2000 years ago, rain water was collected from the eaves of rooftops then funneled into traditional jars and pots. In China rain water harvesting has long been used in the loess plateau regions of China. Storm water ponds of various sizes lined with red clay at the bottom to minimize seepage were also used."[2] RWH for irrigation was recorded in India as early as the third century.

Desalinization

In the future, desalinization will likely be a panacea for water scarcity yet today the technology is prohibitively expensive to establish and operate, energy intensive, and outside the practical reach for many impoverished countries and citizens. Sea water is composed of 35,000 parts per million (ppm) of dissolved solids such as calcium, sodium chloride, and magnesium salts. In order to be drinkable, water must have less than 500 ppm dissolved solids. Desalinization operates by removing these solids from sea water. The modern technological process commonly used is Reverse Osmosis whereby the water is forced through filters or membranes, separating the salt and solids from the water. Multistage Flash Distillation is a type of thermal desalination whereby salt water is heated under intense pressure. Through the multistage process, salts and solids are removed leading to condensation into eventually distilled water. Multiple Effect Distillation is a form of thermal desalination. Salt water is heated under intense pressure and pushed through a chamber. Through several stages the heat derived from condensation leads to the formation of distilled water. There are approximately 17,000 desalination facilities worldwide and operations

in more than 150 countries. Yet only 4 percent of global population is utilizing water from desalinization processes.

Cloud Seeding

Cloud seeding is a method of weather modification that was first developed in the United States in the 1940s. The practice involves the injection of silver iodide or dry ice which is solid carbon dioxide into clouds to trigger precipitation. Today, 24 countries utilize cloud seeding.

When moisture congeals around particles in the atmosphere, a saturation point occurs that produces rainfall. Cloud seeding accelerates this process by adding the nuclei around which water condensation can take place. The nuclei may consist of silver iodine, dry ice, or calcium chloride. The benefits of cloud seeding can be significant. Experiments in Russia, the United States, Australia, China, India, Morocco, Syria, and other countries have demonstrated that artificial cloud seeding can increase the quantity of rainfall between 5 percent and 20 percent over large areas and relatively long durations, monthly or over the rainy season.[3] Beijing, which is hampered by low annual rainfall levels, was given cloud seeding applications before the 2008 Olympics to help clear the air of pollutants. The King of Thailand holds a patent for cloud seeding that has been used in the country to combat regional drought prone conditions affecting farmers.

In order to facilitate successful cloud seeding, specific technological requirements and equipment are needed. These include "aircraft, a meteorological station network to monitor the clouds, a rainfall monitoring ground network, a network for data collection and processing, and a satellite image transmission networks. Cooling material and silver iodide are usually used at a concentration of 2%, for seeding clouds with graded microstructures. Dispensing the material from the top of the cloud produces better results than dispensing it from the bottom."[4]

There are three methods of cloud seeding: static, dynamic, and hygroscopic. Static cloud seeding requires the infusion of a chemical such as silver iodide into clouds. The silver iodide leads to crystallization around which moisture is condensed. Dynamic cloud seeding raises the vertical air currents which facilitates more water to pass through the clouds thus producing more rainfall. Hygroscopic cloud seeding involves the dispersal of salts through flares inside the lower mass of the clouds. As the salt increases in size, water is conjoined with the salt thus leading to rainfall. Water harvesting, desalinization, and

cloud seeding are pragmatic approaches that can contribute to reduced water scarcity in many regions.

Water represents the most precious resource on the planet and the paramount human rights crisis of our century. The global community has passed the point of urgency because of the threatening conditions of current water scarcity affecting 800 million citizens and the looming crisis of climate change which is already evident. Climate change experts recognize that a disproportionate share of the burden will fall upon people in the developing world. Yet human history is infused with ingenuity and optimism and countless examples whereby crises have been surmounted. Water scarcity represents the ultimate human rights and development challenge yet it is a challenge that is within the capacity of the global community to address responsibly.

NOTES

Introduction

1. Ali Gold Roberts, MIT Joint Program on the Science and Policy of Global Climate Change, January 9, 2014.
2. United Nations Joint Monitoring Programme (JMP), 2013.
3. Janet Abramovitz, "Imperiled Waters, Impoverished Future: The Decline of Freshwater Ecosystems" (Worldwatch Paper No. 128). Washington, DC: Worldwatch Institute, 1996.
4. Don Hinrishsen and Henrylito Tacio, "The Coming Freshwater Crisis Is Already Here," The Wilson Center, July 2011.
5. Catarina de Albuquerque, *United Nations Report of the Special Rapporteur on the Human Right to Safe Drinking Water and Sanitation*, A/HRC/24/44, July 11, 2013.
6. "Ghana and Uganda to Pilot New Model to Improve Rural Water Services," IRC International Water and Sanitation Center, 2009.
7. S. Sutton, "Preliminary Desk Study of Potential for Self-Supply in Sub-Saharan Africa" (2004).
8. United Nations Economic and Social Council, Committee on Economic, Social and Cultural Rights, General Comment No.15 (2002) The right to water (Arts. 11 and 12 of the International Covenant on Economic, Social and Cultural Rights) Twenty-ninth session, Geneva, 11–29 November 2002. E/C. 12/2002/11.
9. Universal Declaration of Human Rights (UDHR), G.A. Res. 217A (III) (1948), Art. Xx. Available at http://www.un.org/Overview/rights.html.
10. International Covenant on Civil and Political Rights (ICCPR), G.A. Res. 2200A (XXI) (1966), Art. xx. Available at http://www2.ohchr.org/english/law/cescr.htm.
11. United Nations Economic and Social Council, Committee on Economic, Social and Cultural Rights, General Comment No.15 (2002) The right to water (Arts. 11 and 12 of the International Covenant on Economic, Social and Cultural Rights) Twenty-ninth session, Geneva, 11–29 November 2002. E/C. 12/2002/11.
12. Ibid.
13. Catarina de Albuquerque, *United Nations Report of the Special Rapporteur on the Human Right to Safe Drinking Water and Sanitation*, A/HRC/24/44, July 11, 2013.

14. C. Ramachandraiah, "Right to Drinking Water in India," working paper no. 56, Center for Economic and Social Studies, 2004, p. 7.
15. Lopez A. D., Mathers C. D., Ezzati M., Jamison D. T., Murray C. J. L. (eds.) "The Burden of Disease and Mortality by Condition: Data, Methods, and Results for 2001," in Global burden of disease and risk factors (New York: Oxford University Press) 45–240, 2006.
16. Bern M. Kosek, "The Global Burden of Diarrheal Disease, an Estimate from Studies Published," 2003.
17. *Water: A Shared Responsibility*, United Nations World Water Development Report 2, United Nations, New York, March 2006.
18. Ibid.
19. Ibid.
20. Ibid.
21. Ibid.
22. Asia Water Development Outlook 2013, Asian Development Bank (ADB) and the Asia-Pacific Water Forum, ADB, 2013, p. 37.
23. Ibid.
24. Ibid.
25. Ibid.
26. Ibid.
27. Ibid., p. 38.
28. Ibid., p. 39.
29. GLAAS 2012 Report, *UN Water*, 2012.
30. Asia Water Development Outlook 2013, Asian Development Bank (ADB) and the Asia-Pacific Water Forum, ADB, 2013, p. 19.
31. William, R. L., Anderegg, J. W. Prall, J. H. and Stephen H. Schneider, "Expert Credibility in Climate Change," *PNAS*, vol. 107, no. 27, July 6, 2010.
32. United Nations, *Intergovernmental Panel on Climate Change (IPCC) Report*, 2014.

1 Myanmar: Resolving Water Insecurity and Poverty

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1. WHO Country Co-operation Strategy, Myanmar (2014–2018). World Health Organization, Country Office for Myanmar, 2014.
2. MNPED and CSO (2012). *Statistical Yearbook* 2011. Nay Pyi Taw: Ministry of National Planning and Economic Development and Central Statistical Organization.
3. FAO (2013). FAO's Information System on Water and Agriculture.
4. Hiroshi Sakai, Yatasuka Kataoka, and Kensuke Fukushi, "Quality of Source Water and Drinking Water in Urban Areas of Myanmar," *The Scientific World Journal,* Hindawi Publishing Corporation, vol, ID 854261, 2013.

5. CIA World Fact Book, *Major Infectious Diseases*, 2013.
6. UNICEF, WHO, World Bank, UN, 2013.
7. IWRM (2010). *Identifying Priority Investments in Water in Myanmar's Dry Zone.* Final Report for Component 3 International Water Management Institute.
8. Department of Health and UNICEF (2011). "Knowledge, Attitude and Practice Study into Water, Sanitation and Hygiene in 24 townships of Myanmar." Yangon, Myanmar.
9. Wah-Wah-Aung et al. (2014). "Etiological agents of acute diarrhea in hospitalized children in Yangon Region." Unpublished document.
10. NMCP (2014). "Mobility dynamics of migrant workers and their socio-behavioral parameters related to malaria in Tier II, Artemisinin Resistance Containment Zone, Myanmar." Unpublished Report. National Malaria Control Programme in collaboration with Department of Medical Research (Lower Myanmar).
11. Ministry of Social Welfare, Relief and Resettlement, 2012.
12. World Bank, FAO, 2008.
13. WHO Office—Myanmar. May 2008.
14. 29th WEDC International Conference Abuja, Nigeria, 2003. "Arsenic contamination of water sources in rural Myanmar." Tet Nay Tun, Myanmar.
15. Tet Nay Tun (2002) Myanmar.
16. National Water Policy Draft: 1.0, August, 2013.
17. DMR-LM (2013). Annual Report, 2012. Department of Medical Research (Lower Myanmar), Yangon, Myanmar.
18. The Millennium Project. 2010. "Environmental change and biodiversity."
19. Burma Rivers Network, 2015.
20. Khin-Thet-Wai, Kay-Thwe Han, Kyi Lwin Oo, Wah Wah Aung, Tin Oo, Su Latt, Kyaw Zin Thant, and Tun Myint (2014). "Ecosystems, Aquaculture and Potential Vulnerability to Schistosomes and Food-borne Trematodes in Fresh Water Wetlands, Myanmar." In Proceedings of The 14th Annual Workshop on Regional Network of Asian Schistosomiasis plus Zoonotic Helminthes (RNAS+) 2014, International Convention Center, Bogor, Indonesia.
21. S. Kreft, D. Eckstein, L. Junghans, C. Kerestan, and U. Hagen, "Who Suffers Most from Extreme Weather Events? Weather-related Loss Events in 2013 and 1994 to 2013." Global Climate Risk Index, German Watch, 2015.
22. The Myanmar National Adaptation Programme of Action (NAPA) Report, United Nations Environment Programme (UNEP) and the Department of Meteorology and Hydrology, Ministry of Transport of Union of the Republic of Myanmar, 2012.
23. Ibid.

2 Cambodia: A Rural Water Crisis

1. Aquapedia Case Study Database: Water Quality in Phenom Penh, Cambodia, May 2013.

2. Ibid.
3. Ibid.
4. ICPD, International Conference on Population and Development, July 2012.
5. United Nations Environment Programme, "Freshwater under Threat: Southeast Asia," UNEP, 2009.
6. K. Irvine and T. Koottatep (2010). "Guest Editorial: Natural Wetlands Treatment of Sewage Discharges from Phnom Penh, Cambodia: Successes and Future Challenges." *Asian Journal of Water, Environment and Pollution,* 7(3); S. Muong (2004). *Avoiding Adverse Health Impacts from Contaminated Vegetables: Options for Three Wetlands in Phnom Penh, Cambodia*. Economy and Environment Program for Southeast Asia, Research Report No. 2004-RR5, Singapore.
7. U. Heinonen (2008). "Millennium Development Goals and Phnom Penh: Is the City on Track to Meet the Goals?" In *Modern Myths of the Mekong*, ed. Kummu, M., Keskinen, M., and Varis, O., Helsinki University of Technology—TKK, Helsinski, pp. 95–105.
8. Pierre Fallavier (2003) "Understanding Slums: Case Studies for the Global Report on Human Settlements 2003, the Case of Phnom Penh," Department of Urban Studies and Planning, Massachusetts Institute of Technology.
9. Ministry of Water Resources and Meteorology, Royal Government of Cambodia, 2007.
10. Asian Development Bank Cambodia (2014). *Diversifying beyond Garments and Tourism*. Mandaluyong City, Philippines.
11. Ibid.
12. Marcus F. Aguilar (2010), *Access to Safe Drinking Water in Cambodia: Available Sources and Point of Use Water Treatment,*Department of Civil, Construction, and Envi ronmental Engineering, University of Alabama, Tuscaloosa, *JOSHUA,* May; vol. 7.
13. Ibid.
14. Royal Government of Cambodia (2006), *National Adaptation Programme of Action to Climate Change* (NAPA) Phnom Penh: Ministry of the Environment.
15. K. Phan, S. Sthiannopkao, K. W. Kim, M. H. Wong, V. Sao, J. H. Hashim, M. S. Mohamed Yasin, S. M. Aljunid, "Health risk assessment of inorganic arsenic intake of Cambodia residents through groundwater drinking pathway," *Elsevier,* 2010.
16. K. W. Kim, P. Chanpiwat, H. T. Hanh, K. Phan, S. Sthiannopkao (2010) "Arsenic geochemistry of groundwater in Southeast Asia," *Medline*, 2010.
17. M. Berg, C. Stengel, T. K. Pham, H. V. Pham, M. L. Sampson, M. Leng, S. Samreth, D. Fredericks (2009) "Magnitude of arsenic pollution in the Mekong and Red River Deltas—Cambodia and Vietnam." Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland.
18. NAPA Government Cambodian Report, Climate Change 2006.
19. Aquapedia,M ay2 013.
20. A. Shicavone (2010). "Trade and climate change implications for food security in mainland Southeast Asia." International Institute for Sustainable Development.
21. NAPA Government Cambodian Report, Climate Change 2006.

22. WHO, 2012.
23. World Health Organization (2012), *Strengthen Control of Vector-borne Diseases to Lessen the Impact of Climate Change in the Western Pacific Region with Focus on Cambodia, Mongolia and Papua New Guinea*. Final Project Report, Western Pacific Region.
24. Water Environment Partnership in Asia (WEPA), 2013.
25. M. Berg, C. Stengel, T. K. Pham, H. V. Pham, M. L. Sampson, M. Leng, S. Samreth, D. Fredericks (2009). "Magnitude of Arsenic Pollution in the Mekong and Red River Deltas—Cambodia and Vietnam." Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland.
26. C. M. Tarr (2003). "Fishing Lots and People in Cambodia." In *Social Challenges for the Mekong Region*, second edition, M. Kaosa-ard and J. Dore (eds.) (Bangkok, Thailand: White Lotus).
27. T. P. Murphy, K. N. Irvine, M. Sampson, J. Guo, and T. Parr (2008), "Mercury Contamination along the Mekong River, Cambodia" *Asian Journal of Water, Environment and Pollution*, vol. 6, no.1.
28. T. Agusa, T. Kunito, H. Iwata, I. Monirith, T. S. Tana, A. Subramanian, S. Tanabe (2005). "Mercury Contamination in Human Hair and Fish from Cambodia: Levels, Specific Accumulation and Risk Assessment," *Environmental Pollution*, March; 134 (1): 79–86.

3 India: Drought, Climate Change, and Poverty

1. National Water Mission (NWM). 2009. Ministry of Water Resources, Government of India. Available at: http://india.gov.in/allimpfrms/alldocs/15658.pdf.
2. Water Supply and Sanitation, WHO-UNICEF Sponsored Study, Government of India, Planning Commission, 2002.
3. Government of India, Planning Commission, 2010.
4. Country Strategy: India, 2011–2016, Water Aid.
5. Ibid.
6. Pollution in Yamuna River, compiled by Yash Vardhan Jain and Chetan Singh, 2012.
7. Z. S. Ahammad, T. R. Sreekrishnan, C. L. Hands, C. W. Knapp, and D. W. Graham, "Increased Waterborne $bla_{\text{NDM-1}}$ Resistance Gene Abundances Associated with Seasonal Human Pilgrimages to the Upper Ganges River," in *Environmental Science and Technology*, March 4, 2014; 48(5): 3014–3020.
8. Dipak Kumar Dash, "22 of India's 32 Big Cities Face Water Crisis," *Times of India*, September 9, 2013.
9. Ramandeep Kaur, "The Most Polluted River Yamuna," *Maps of India*, January 7, 2014.
10. Central Pollution Control Board (2009), "Status of Water Supply, Wastewater Generation and Treatment in Class-I Cities & Class-II Towns of India," Central Pollution Control Board, Government of India.

11. G. Kumar, "Necessity of Bottled Water Industry in India–Some Facts," in *Chemical Science Review and Letters*, 3(12), 2014.
12. WaterAid "Country Strategy: India," 2011–2015.
13. CIA World Fact Book on major infectious diseases 2014.
14. Million Death Study Collaborators, Bassani D. G., Kumar R., Awasthi S., Morris S. K., Paul V. K. et al. "Causes of Neonatal and Child Mortality in India: A Nationally Representative Mortality Survey." *Lancet* 2010; 376:1853–60.
15. Rakesh Lodha and Dheerraj Shah, "Prevention of Rotavirus Diarrhea in India: Is Vaccination the Only Strategy?" *Indian Pediatrics* 441, vol. 49, June 16, 2012.
16. Ibid.
17. WHO-UNICEF. 2010. Estimates for the Use of Improved Drinking Water Sources. Joint Monitoring Programme for Water Supply and Sanitation. Available at: http://www.wssinfo.org/
18. Planning Commission. 2008. Eleventh Five Year Plan 2007–2012.
19. Global Governance Project, 2012.
20. Intergovernmental Panel on Climate Change, IPCC 1990.
21. World Bank, "India Groundwater: A Valuable but Diminishing Resource," news release, March 6, 2012.
22. Chella S. Rajan (2008), "Blue Alert," Greenpeace India Society, www.greenpeaceindia.org
23. S. Dasgupta, B. Laplante, S. Murray, and D. Wheeler (2009), "Sea-level Rise and Storm Surges: A Comparative Analysis of Impacts in Developing Countries," policy research working paper no. 4901, World Bank.
24. D. Anthoff, R. Nicholls, R. Tol, A. Vafeidis (2006), "Global and Regional Exposure to Large Rises in Sea-Level: A Sensitivity Analysis," working paper no. 90. Tyndall Centre for Climate Change Research, Norwich, London.
25. Census 2011. Main Sources of Drinking Water 2001–2011. Retrieved from http://www.censusindia.gov.in/2011census/hlo/Data_sheet/India/Drinking_Water.pdf.
26. R. Wassmann, S. V. K. Jagadish, K. Sumfleth, H. Pathak, G. Howell, A. Ismail, R. Serraj et al. (2009), Regional Vulnerability of Climate Change Impacts on Asian Rice Production and Scope for Adaptation, *Advances in Agronomy*, 102(09), 91–133.
27. C. Ramachandraiah, "Right to Drinking Water in India," working paper no. 56, Center for Economic and Social Studies, 2004, p. 7.
28. Constitution Act of India, 1949, Article 17.
29. Ghanshyam Saha, Satish Deshpande, Sukhadeo Thorat, Harsh Mander, and Amita Baviskar "Untouchability in Rural India," SAGE Publications, New Delhi,2 006.
30. "National Campaign on Dalit Human Rights and International Dalit Solidarity Network Caste Based Discrimination in India—Key Recommendations and Questions," thirteenth session of the Universal Periodic Review of the Human Rights Council–India, *Review of India*, May 24, 2012.
31. *Alternate Report to the Joint 2nd to 5th Periodic Report of the State Party (Republic of India) to the Committee on Economic, Social and Cultural Rights on the Implementation*

of International Covenant on Economic, Social and Cultural Rights. (A periodic report submitted by the state parties under Articles 16 and 17 of the Covenant) National Campaign on Dalit Human Rights (NCDHR) New Delhi, India, 2008.
32. Planning Commission, Government of India, 2008.
33. Ministry of Rural Development, DDWS, GOI, 2011.
34. *NATCOM National Communication 2004: NATCOM Final Report*. http://www.natcomindia.org/natcomreport.htm.
35. NASA, Jordan Camp, "Melting Glaciers of Tibet," Climate Change Research at NASA—Goddard Space Flight Center, 2010.
36. National Water Mission (NWM). 2009. Ministry of Water Resources, Government of India.
37. Asian Water Development Outlook, 2013 ADB.
38. Wassmann, Jagadish, Sumfleth et al., 2009.
39. "Climate Change and India: A 4X4 Assessment a Sectoral and Regional Analysis for the 2030s," *INCCA: Indian Network for Climate Change Assessment*, Ministry of Environment and Forests, Government of India, 2010.
40. Kiran Pandey, "Costs of Adapting to Climate Change for Human Health in Developing Countries," World Bank, discussion paper no. 1, December 2010.
41. Ibid.
42. Pollution Assessment: River Ganga, July, 2013, Central Pollution Control Board, Ministry of Environment and Forests, Government of India.
43. Ibid.
44. Ibid.
45. Ibid.
46. Priyam Das and Kenneth R. Tamminga, "The Ganges and the GAP: An Assessment of Efforts to Clean a Sacred River," *Sustainability* 2012, 4(8).
47. S. A. Iqbal and Nilofar Iqbal, "Assessment of heavy metal pollution in Upper and Lower lakes of Bhopal (India) Vandana Masgarde," Saifia College of Science and Education, Bhopal, India, 2009.
48. Aniruddhe Mukerjee, "India: Relocation of a washing community to reduce urban lake pollution #245," 2005.
49. "Amruthavarshini—A guide for Rainwater Harvesting" published by Karnataka State Council for Science and Technology.
50. A. Agarwal (2001), "Drought? Try Capturing the Rain." Briefing paper for members of parliament and state legislatures, occasional paper, Centre for Science and Environment, New Delhi.
51. T. Ruf (1998), "Du passage d'une gestion par l'offre en eau à une gestion par la demande sociale: Ordre et désordre dans les questions d'irrigation et de conflits d'usage de l'eau". Paper presented at "atelier 3 du IRD" November 1998. IRD, Montpellier."
52. C. Batchelor, R. M. Rao, M. Rao (2003), "Watershed Development: A Solution to Water Shortages in Semi-Arid India or Part of the Problem," in *Land and Water Resources Review*, 3, 1–10.
53. A. Agarwal (2001), "Drought? Try Capturing the Rain." Briefing paper for members of parliament and state legislatures, occasional paper, Centre for Science and Environment, New Delhi.

54. Sharma, B. R., K. V. Rao, K. P. R. Vittal, and U. Amarasinghe (2008), *Converting rain into grain: Opportunities for realizing the potential rain-fed agriculture in India*. Proceedings National Workshop of National River Linking Project of India, International Water Management Institute, Colombo (pp. 239–252) available at http://www.iwmi.cgiar.org/Publications/Other/PDF/NRLP%20Proceeding-2%20Paper%20" from: *Rainwater Harvesting: A Lifetime for Human Well-Being*. A report prepared for UNEP by Stockholm Environment Institute, 2009.
55. Rajendra Singh, email to author on April 30, 2015.

4 Indonesia: One of the Most Polluted Countries in the World

1. Asian Water Development Outlook 2013, ADB, April, 2013.
2. *Southeast Asia, Evaluation of the Status of IWRM Implementation in 2000–2010 in Respect to Policy, Legal and Institutional Aspects*. Vol. 1, Global Water Partnership Southeast Asia, 2011.
3. A. Tejalaksana (State Ministry of Environment Indonesia) 2010, "Urbanization and water quality control for the sources of in Jakarta" Proceedings of Water Environment Partnership in Asia (WEPA) First International Workshop, March, 2010.
4. Ibid.
5. UN Habitat, *The Challenge of Slums*, UN Human Settlements Programme, 2003.
6. V. P. Fournier, P. Folliasson, L. Martin, et al., "Palyja 'Water for All' Programmes in Western Jakarta," in *Investing in Water for a Green Economy*, eds. Mike D. Young and Christine Esau, 2013.
7. Ibid.
8. *Indonesia: WaSH Sector Brief.*
9. Ibid.
10. *Safe Water, Better Health*, WHO (2008).
11. "Indonesia Clean Drinking Water Crisis Worst in Asia: Expert" *Jakarta Globe*, July 5, 2012.
12. CIA World Fact Book on major infectious diseases, 2014.
13. Sean Fitzwater, Aruna Chandran, Margaret Kosek, Mathurum Santosham, "Infectious Diarrhea," in *Water and Sanitation-Related Diseases and the Environment: Challenges, Interventions and Preventive Measures,* ed. Janine M. H. Selendy. Wiley-Blackwell Publishers, 2011.
14. M. K. Singh and Anil Kumar, "A Global Problem of Arsenic in Drinking Water and Its Mitigation—A Review," in *International Journal of Advanced Engineering Technology and Poisoning*, vol. III, January-March, 2012.
15. Muhammad Ilyas, Agus Sudaryanto, Yudi Anantasena, Shin Takahashi, and Shinsuke Tanabe, "Is Arsenic a Potential Threat for Human Health in Indonesia," in *Interdisciplinary Studies on Environmental Chemistry—Environmental Research in*

Asia, eds. Y. Obayashi, T. Isobe, A. Subramanian, S. Suzuki, and S. Tanabe. P. Terrapub,2 009.

16. *Indonesia Country Study: East Asia Pacific Region Urban Sanitation Review.* World Bank, 2013.
17. ESCAP (2006, 2010a), Dilley et al. (2005), FAO AQUASTAT database, 2010.
18. *Indonesia Country Study: East Asia Pacific Region Urban Sanitation Review.* World Bank, 2013.
19. *Indonesia: WaSH Sector Brief.*
20. *Indonesian Environmental Status Report*, Government of Indonesia, 2014.
21. *Asia–Pacific Network for Global Change Research*, Issue 3, March, 2013.
22. "Downstream Impacts of Water Pollution in the Upper Citarum River, West Java, Indonesia," World Bank, October, 2013.
23. Ibid.

5 Laos: The Poorest Country in Asia

1. Constitution of Laos, articles 19 and 25. Adopted August 15, 1991.
2. WEPA,2 010.
3. "National Plan of Action for Rural Water Supply, Sanitation and Hygiene," Lao Peoples Democratic Republic, Ministry of Health, 2012.
4. WEPA,2 010.
5. *The Millennium Development Goals Progress Report for the Lao PDR 2013*, jointly prepared by the Government of the Lao PDR and the United Nations.
6. CIA, The World Factbook, Major Infectious Diseases, 2014.
7. Water and Sanitation Program (WSP) Lao PDR (2009) Economic Impacts of Sanitation (ESI) Study, 2009.
8. Department of Hygiene and Disease Prevention, Ministry of Health, Vientiane, Lao.
9. P. Chanpiwat, S. Sthiannopkao, K. H. Cho, K. W. Kim, V. San, B. Suvanthong, and C. Vongthavady, "Contamination by arsenic and other trace elements of tube-well water along the Mekong River in Lao PDR."
10. *The Millennium Development Goals Progress Report for the Lao PDR 2013*, jointly prepared by the Government of the Lao PDR and the United Nations.
11. World Bank Water and Sanitation Program (WSP). "Economic Impacts of Sanitation in Lao PDR." A five-country study conducted in Cambodia, Indonesia, Lao PDR, the Philippines, and Vietnam under the Economics of Sanitation Initiative (ESI) 2009.
12. *The Millennium Development Goals Progress Report for the Lao PDR 2013*, jointly prepared by the Government of the Lao PDR and the United Nations.
13. Gretchen A. Kunze, "World Water Day: Laos Hardest Hit by Mekong's Falling Water Levels," *The Asia Foundation*, March 17, 2010.
14. J. F. Eastham, M. Mpelasoka, M. Mainuddin, C. Ticehurst, P. Dyce, G. Hodgson, R. Ali, and M. Kirby (2008). *Mekong River Basin Water Resources Assessment:*

Impacts of Climate Change. CSIRO: Water for a Healthy Country National Research Flagship Mekong River Basin Water Resources Assessment, 2008.
15. Ibid.
16. Ibid.

6 People's Republic of China: Confronting Catastrophic Drought and Pollution

1. World Bank, "China Overview," 2015.
2. Joint Monitoring Program for Water Supply and Sanitation: Estimates for the use of Improved Sanitation Facilities, China and Estimates for the use of Improved Water Facilities, March 2010.
3. World Bank, "China Overview," 2015.
4. Aquastat, "China–Year 2011," FAO, 2011.
5. Ibid.
6. S. T. Li, 2006. Urban Water Pollution Issues. *China Youth*, 09/13/2006.
7. MWR (Ministry of Water Resources, P. R. China) 2007b. The Eleventh Five-Year Plan of National Water Resource Development. Gazette of the Ministry of Water Resources of the P.R. China 2007, 34–48.
8. T. C. Tso, Agriculture of the future. *Nature* 428, 2004.
9. Wu and Shi in *Water Sources in Shanghai*.A IT,1 999.
10. Ward and Liang in *Water Sources in Shanghai*.A IT,1 999.
11. Ibid.
12. *Water Sources in Shanghai*,A IT,1 999.
13. S. F. Balica et al., "A Flood Vulnerability Index for Coastal Cities and its Use in Assessing Climate Change Impacts," *Natural Hazards*, 2012.
14. *Yangtze River Water Resources Commission Report*,2 005.
15. T. J. Doyle, W. Zheng, J. R. Cerhan, C. P. Hong, T. A. Sellers, L. H. Kushi, and A. R. Folsom, "The Association of Drinking Water Source and Chlorination By-Products with Cancer Incidence among Postmenopausal Women in Iowa: A Prospective Cohort Study," in *The American Journal of Public Health*, 87(7), July 1997.
16. CIA World Fact Book on major infectious diseases, 2014.
17. Elizabeth J. Carlton, Song Liang, Julia Z. McDowell, Huazhong Li, Wei Luo, and Justin V. Remais, "Regional Disparities in the Burden of Disease Attributable to Unsafe Water and Poor Sanitation in China," Bulletin of the World Health Organization, 90: 2012.
18. *Organization for Economic Cooperation and Development OECD Report*, 2007.
19. *Asia Economic News, 2007.*
20. *Environment and People's Health in China*, World Health Organization, United Nations Development Programme, 2001.
21. Statement from World Bank China Country Director on *Cost of Pollution in China Report*, Press Release, July 11, 2007.
22. W. Changhua, M. Gottlieb, D. Davis, "China's Environment and Health," in *World Resources 199–1999*. Washington, DC: World Resources Institute, 1998.

23. *World Cancer Report*, World Health Organization, 2014.
24. China Water Risk, "China's Water Crisis Part II," March, 2010.
25. World Bank, "Addressing China's Water Scarcity: Recommendations for Selected Water Resource Management Issues," 2009.
26. Kota Katanoda, "The Dynamics of Cancer Burden in Asia," in *Annals of Translational Medicine*, vol. 2, no. 7, July, 2014.
27. Lin Nian-Feng, Tang Jie Tang, and Bian Jian-Min. 2002. "Characteristics of Environmental Geochemistry in the Arseniasis Area of the Inner Mongolia of China," *Environmental Chemistry and Health* 24: 249–259, Ministry of Health (MoH), 2004.
28. De-long Su. 1980. "Drinking Water and Liver Cancer," *Chinese Preventive Medicine* 14(2): 65–73.
29. Xu Houquan, HAN Yurong, Hu Ping et al. 1995. "The Case-Control Study on the Human Liver Cancer Risk Factors in the Nansihu," *Journal of Environment and Health*, 12(5): 210–212.
30. Xu Houquan, Yurong Han, Fabin Han et al. 1994. "The Retrospective Cohort Study on the Water Pollution and Tumor in Nansihu," *Journal of Environment and Health*, 11(3): 133–134.
31. Wang Qian, Chen Changjie, Huang Wei, et al. 1992. "The Correlative Study on the Chinese Drinking Water Organic Pollution and the Mortality Rate of Liver Cancer," *The Healthy Research* 21(4): 181–183.
32. Wang Zhiqiang. 1997. "The Study on Different Water Source, Water Improvement and Gastric Cancer Mortality in High Incidence Area Changle County," *The Transactions of the China Public Health* 16(1): 7–10.
33. J. R. Hu, 1994. "Status of Ground Water in the Sewage Storage Project in the Upper Reach of Baiyangdian and its Influences on the Health of Residents," *Huanjing Yu Jiankang Zazhi* (*Journal of Environment and Health*) 14(1): 3–5.
34. Pan Xiaochuan and Jiang Jinhua. 2004. *A study of the exposure-response relationship between human health and water pollution in the Yangtze and Huai River basins of China*. Internal Project Report.
35. Ibid.
36. The Twelfth Five-Year Plan for the Environmental Health Work of National Environmental Protection, Ministry of Environmental Protection of the People's Republic of China, September 21, 2011.
37. Z. Chen, Ministry of Health of China, The Third National Survey on Causes of Death (Beijing: China Union Medical University Press, 2008.
38. Ibid.
39. H. Li, "Defeated by Cancer: Cancer Country," *Caijing* 215 (July 7, 2008): 80–88.
40. Ibid.
41. CCTV, Hai River Pollution Control Gratitude and Grievance, Shenghuo Shibao, November 9, 1998.
42. S. Wang, J. Lin, S. Shi, and J. Zhang, "Geological Disease Caused by Ecological Environment: An Example of Cancer Village in Shaanxi Province," *Environmental Protection*, May (2001): 42–43.
43. Ibid.

44. China Quality Ten-Thousand-Li Journey, Undercover Investigation in Xiditou Township in Tianjin: Over 120 Cancer Victims from Industrial Pollution, March 1,2 005.
45. H. Li, "Defeated by Cancer: Cancer Country," *Caijing* 215 (July 7, 2008): 80–88.
46. Lee Liu, "Made in China: Cancer Villages," *Environment Magazine*, March–April, 2010.
47. CCTV, Hai River Pollution Control Gratitude and Grievance, Shenghuo Shibao, November 9, 1998.
48. Q. Liu and L. Chen, "On the Lack of Operation System of Environment Law of China in View of a Cancer Village," *Journal of Shiyan Technical Institute* 20, no. 2 (2007): 18–20.
49. W. Wang, "Campaigner Wages War on Cancerous River," *Global Times*, June 21, 2009.
50. The World Bank and the State Environmental Protection Administration, P. R. China, "Cost of Pollution in China: Economic Estimates of Physical Damages," 2011.
51. Bixiong Ye, Linsheng Yang, Yonghua Li, Wuyi Wang, and Hairong Li, "Water Sources and Their Protection from the Impact of Microbial Contamination in Rural Areas of Beijing, China," *International Journal of Environmental Research and Public Health*,M arch,2 013.
52. "Over 40% of Rural Areas' Drinking Water Unhealthy, *Xinhua News Agency*, 2008. Available online: www.china.org.cn/english/environment/243133.htm
53. Bixiong Ye, Linsheng Yang, Yonghua Li, Wuyi Wang, and Hairong Li, "Water Sources and Their Protection from the Impact of Microbial Contamination in Rural Areas of Beijing, China," *International Journal of Environmental Research and Public Health*,M arch2 013.
54. Jiang Yong, "Water Scarcity–China," *Encyclopedia of Earth,* August 10, 2010.
55. The World Bank Group, "Addressing China's Water Scarcity," January, 2009.
56. Michael Ma, "Northern Cities Sinking as Water Table Falls," *South China Morning Post*, August 11, 2001.
57. Gabriel Wong, "Slaking the Thirst of a Huge Nation," *Gridlines*, Spring, 2013.
58. *China Daily*, March 22, 2012, www.chinadaily.com.cn/china
59. FAO, "Drylands Development and Combating Desertification," 2013.
60. Jiang Yong, "Water scarcity–China," *Encyclopedia of Earth*, August 10, 2010.
61. Yellow River Conservancy Commission, "Yellow River Basin Issues and Management," 2012.

7 The Philippines: Devastated by Climate Change

1. Assessment of the Philippine Agenda 21, the Prospects for a Green Economy and the Institutional framework for Sustainable Development, Final Draft.
2. Government of the Philippines, National Statistical Coordination Board. 2012. Summary of State Development 2011 Indicators by Sector and by Pace of Performance.

3. WHO Country Cooperation Strategy for the Philippines 2011–2016, 2011.
4. Secretary Bebet Gozun, Department of Environment and Natural Resources (DENR),2 004.
5. Project Information Document (PID) Concept Stage Report No.: AB1740 World Bank,2 005.
6. United Nations Department of Economic and Social Affairs/Population Division World Urbanization Prospects: The 2007 Revision.
7. The Philippine Institute for Development Studies (PIDS).
8. Philippine Environment Monitor: Environmental Health, World Bank, 2006.
9. *National Water Quality Status Report*. Manila, Department of Environment and Natural Resources, Government of the Philippines, 2005.
10. CIA World Factbook, Major Infectious Diseases, 2013.
11. WHO Country Cooperation Strategy for the Philippines 2011–2016, 2011.
12. Government of the Philippines, National Statistical Coordination Board. 2012.
13. World Health Organization, "Public Health Risk Assessment and Interventions—Typhoon Haiyan, Philippines 16 November 2013."
14. Ibid.
15. Asian Development Bank. "Philippines: Water Supply and Sanitation Sector Assessment, Strategy, and Road Map," 2013.
16. Ibid.
17. United Nations, Intergovernmental Panel on Climate Change Report (IPCC) 2014.
18. Maplecroft, http://maplecroft.com/about/news/ccvi.html.
19. David Wheeler, "Quantifying Vulnerability to Climate Change: Implications for Adaptation Assistance," working paper 240, Center for Global Development, Washington, DC, USA, January, 2011.
20. World Health Organization, "WHO Country Cooperation Strategy for the Philippines 2011–2016," 2011.
21. The United Nations, Intergovernmental Panel on Climate Change (IPCC) 2014 Report.
22. Milagros Andrea Victoria A. Lazo1, Kristine Kamille P. Nieto, Ma. Felma S. Rayel1, Dominique M. Sto. Domingo, Maria Andrea M. Vergara1 and Rey Donne S. Papa, "Composition, Abundance and Distribution of Rotifers in the Pasig River, Philippines," *Philippines Scientist*, 46: 47–64, 2009.
23. Joan B. Gorme, Marla C. Maniquiz, Pum Song, Lee-Hyung Kim, "The Water Quality of the Pasig River in the City of Manila, Philippines: Current Status, Management and Future Recovery," in *Environmental Engineering Research,* September 15, 2010 (3): 173–179.

8 Thailand: A Struggle against Climate-Change Flooding

1. "Thailand Environment Monitor: Integrated Water Resources Management: A Way Forward," The World Bank, June, 2011.

2. Yoslan Nur, "The Challenges for Urban Water Management in Tropical Coastal Megacities: Bangkok, Jakarta and Manila," 2010.
3. Klemmensen et al., 2000; Kasarda and Parnell, 1993.
4. Ibid.
5. Thailand State of the Environment, 2001.
6. http://www.waterencyclopedia.com/Da-En/Developing-Countries-Issues-in.html#ixzz3NFVsddjg
7. CIA World Fact Book on major infectious diseases, 2014.
8. Freshwater Under Threat—Southeast Asia, UNEP, 2009.
9. Metropolitan Waterworks Authority, NESDB and MWA Annual Report, 2012.
10. Arthur McIntosh, "Urban Water Supply and Sanitation in Southeast Asia: A Guide to Good Practice," Asian Development Bank, 2014.
11. U.N. News Center "UN expert calls on Thailand to eliminate disparities on access to water and sanitation," Feb 8, 2013.
12. Ibid.
13. U.N. News, February 8, 2013.
14. National Stakeholders Consultation Report, GWR Southeast Asia, 2013.
15. Stockholm Environment Institute (SEI), 2012, p. 46.
16. "Screening Study: Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes: Interim Analysis: Exposure Estimates," OECD, 2007.
17. Susan Hanson, Robert Nicholls, N. Ranger. S. Hallegatte, J. Corfee-Morlot·C, Herweijer, J. Chateau, "A Global Ranking of Port Cities with High Exposure to Climate Extremes," *Climatic Change* (2011) 104: 89–111.
18. A. Agarwal, "Forecasting rice yield under climate change scenarios for Northeast Thailand." MS thesis. Department of water engineering and management, Asian Institute of Technology, Thailand, 2008.
19. MWBP [Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme]. Vulnerability assessment of climate risks in the lower Songkhram River Basin, Thailand. Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme. Programme Management Unit, Vientiane-Laos, 2005.
20. "Thailand's Water Vision: A Case Study," Sacha Sethaputra, Suwit Thanopanuwat, Ladawan Kumpa, and Surapol Pattanee Sacha Sethaputra, Khon Kaen University, Khon Kaen, Thailand; Suwit Thanopanuwat, Royal Irrigation Department, Bangkok; Ladawan Kumpa, National Economic and Social Development Board, Bangkok; Surapol Pattanee, Office of the National Water Resources Committee, Bangkok, 2001.
21. Yoslan, Nur. 'The Challenges for Urban Water Management in Tropical Coastal Megacities: Bangkok, Jakarta and Manila," 2010.
22. Thailand Environmental Institute, 1997.
23. Prapaporn Srisathidtham and Wassana Wongrat, "Cloud Seeding Techniques in Eastern Region of Thailand," 2010.

9 Vietnam: A Struggle against Climate-Change Drought

1. WHO UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation.

2. Viet Nam Water and Sanitation Sector Assessment Strategy and Roadmap, Asian Development Bank (ADB), June, 2010.
3. Duc, Hiep Nguyen, "Water Resources and Environment in and around Ho Chi Minh City," *Electronic Green Journal*, 1(19), Environment Protection Authority Truong, Truong Phuoc, University of New South Wales, 2003.
4. Ibid.
5. Ibid.
6. Ibid.
7. *Rural Water Supply, Sanitation, and Health in Vietnam,* Sector Status Report. 2005.
8. General Statistics Office. *Result of the Survey on Households Living Standards (Vietnam) 2002*,2 004.
9. CIA, The World Factbook, Major Infectious Diseases, 2014.
10. N. D. Huong, "Economics of Solid Waste from Various Sources," 2006.
11. P. Thang, H. Tuan, G. Hutton, "Economic impacts of sanitation in Vietnam," World Bank, Water and Sanitation Program, 2008.
12. Ibid.
13. Lenny H. E. Winkel, Pham Thi Kim Trang, Vi Mai Lan, Caroline Stengel, Manouchehr Amini, Nguyen Thi Ha, Pham Hung Viet, and Michael Berg, "Arsenic Pollution of Groundwater in Vietnam Exacerbated by Deep Aquifer Exploitation for More than a Century," *PNAS*, vol. 108, no. 4, 1246–1251, 2007.
14. Tung Bui Huy et al., "Assessing Health Risk Due to Exposure to Arsenic in Drinking Water in Hanam Province, Vietnam," *International Journal of Environmental Research and Public Health*, 7575–7591, 2014.
15. Michael Berg et al., "Magnitude of Arsenic Pollution in the Mekong and Red River Deltas—Cambodia and Vietnam," *Science of the Total Environment*, 372, 413–425, 2007.
16. Hoang Duc Hanh, "The Current State of River Basins in Vietnam–Pollution and Solution," Institute of Environmental Technology and Nguyen The Dong, Ministry of Natural Resources and Environment, 2008.
17. "Wastewater treatment plants need funds," *Vietnam News*, June 6, 2012.
18. "Water Resources Management in Ho Chi Minh City," in *Sustainable Groundwater Management in Asian Cities*,2 008.
19. Ibid.

Conclusion: Innovation and Water Security

1. United Nations, Department of Economic and Social Affairs, Sustainable Development Goals and Targets, 2014.
2. E. Mangore, L. B., Ndlovu, and N. L. Kutshwa, "Rainwater Harvesting for Peri-Urban Poor," Department of Civil and Water Engineering, National University of Science and Technology, Bulawayo, Zimbabwe.
3. "Sourcebook of Alternative Technologies for Freshwater Augmentation in West Asia," United Nations Environment Programme (UNEP), Division of Technology, Industry, and Economics.
4. Ibid.

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