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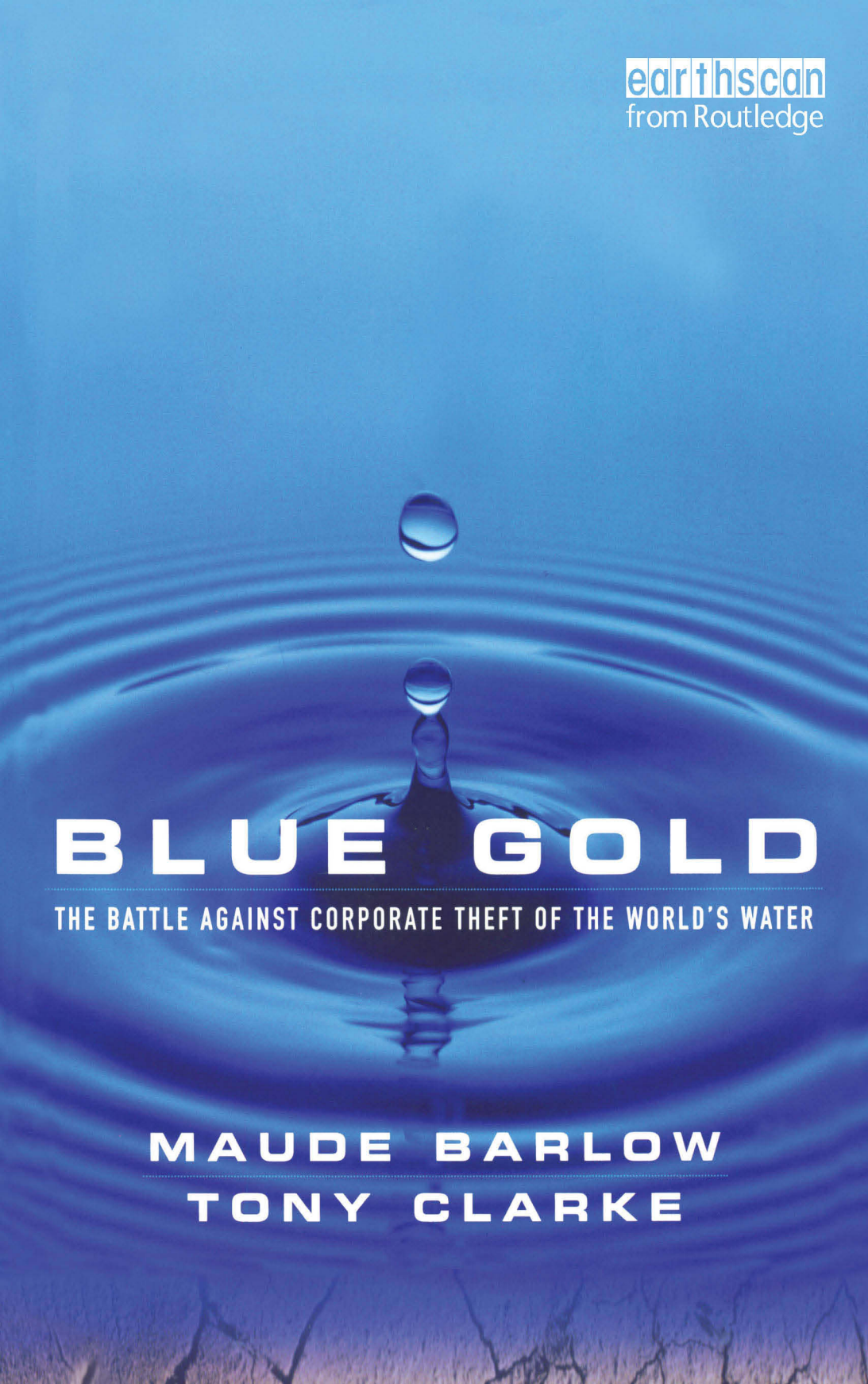

BLUE GOLD

THE BATTLE AGAINST CORPORATE THEFT OF THE WORLD'S WATER

MAUDE BARLOW
TONY CLARKE

Blue Gold

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For KIMY PERNIA DOMICO,
tireless fighter for Indigenous rights to water,
who was "disappeared" by Colombian paramilitary forces
on June 2, 2001. You are dearly missed.

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The Council of Canadians' website which carries Blue Planet Project materials is www.canadians.org.

Maude Barlow and Tony Clarke
Ottawa, Canada, December 2001

INTRODUCTION

Watersheds come in families; nested levels of intimacy. On the grandest scale the hydrologic web is like all humanity — Serbs, Russians, Koyukon Indians, Amish, the billion lives in the People's Republic of China — it's broadly troubled, but it's hard to know how to help. As you work upstream toward home, you're more closely related. The big river is like your nation, a little out of hand. The lake is your cousin. The creek is your sister. The pond is her child. And, for better or worse, in sickness and in health, you're married to your sink.

— MICHAEL PARFIT, NATIONAL GEOGRAPHIC

Suddenly it is so clear: the world is running out of fresh water. Humanity is polluting, diverting, and depleting the wellspring of life at a startling rate. With every passing day, our demand for fresh water outpaces its availability and thousands more people are put at risk. Already, the social,

political, and economic impacts of water scarcity are rapidly becoming a destabilizing force, with water-related conflicts springing up around the globe. Quite simply, unless we dramatically change our ways, between one-half and two-thirds of humanity will be living with severe fresh water shortages within the next quarter-century.

It seemed to sneak up on us. Until the last decade, the study of fresh water was left to highly specialized groups of experts — hydrologists, engineers, scientists, city planners, weather forecasters, and others with a niche interest in what so many of us took for granted. Now, however, an increasing number of voices — Worldwatch Institute, World Resources Institute, United Nations Environment Programme, International Rivers Network, Greenpeace, Clean Water Network, Sierra Club, and Friends of the Earth International, along with thousands of community groups around the world — are sounding the alarm: the global fresh water crisis looms as perhaps the greatest threat ever to the survival of our planet.

Tragically, this global call for action comes in an era guided by the principles of the so-called "Washington Consensus," a model of economics rooted in the belief that liberal market economics constitute the one and only economic choice for the whole world. Key to this "consensus" is the commodification of "the commons." Everything is for sale, even those areas of life, such as social services and natural resources, that were once considered the common heritage of humanity. Governments around the world are abdicating their responsibility to protect the natural resources within their borders, giving authority away to private companies that make a business of resource exploitation.

Faced with the now well-documented fresh water crisis, governments and international institutions are advocating a "Washington Consensus" solution: the privatization and commodification of water. Price water, they say in chorus; put it up for sale and let the market determine its future. For them, the debate is closed. Water, according to the World Bank and the United Nations, is a *human need*, not a *human right*. These are not semantics; the difference in interpretation is crucial. A human need can be supplied in many ways, especially for those with money. But no one can sell a human right.

When water was defined as a commodity at the second "World Water Forum" in The Hague in March 2000, government representatives at a parallel meeting did nothing to effectively counteract the statement. Instead, governments have helped pave the way for private corporations to sell water, for profit, to the thirsty citizens of the world. So a handful of transnational corporations, backed by the World Bank and the International Monetary Fund (IMF), are now aggressively taking over the management of public water services, dramatically raising the price of water to the local residents and profiting especially from the Third World's desperate search for solutions to its water crisis. Some are startlingly open about their motives; the decline in fresh water supplies and standards has created a wonderful venture opportunity for water corporations and their investors, they boast. The agenda is clear: water should be treated like any other tradable good, its use and distribution determined by the principles of profit.

At the same time, governments are signing away their control over domestic water supplies to trade agreements such as the North American Free Trade Agreement (NAFTA); its proposed successor, the Free Trade Area of the Americas (FTAA); and the World Trade Organization (WTO). These global trade institutions effectively give transnational corporations unprecedented access to the fresh water of signatory countries. Already, corporations have started to sue governments in order to gain access to domestic water sources, and armed with the protection of these international trade agreements, they are setting their sights on the mass transport of bulk water by diversion and by supertanker.

So far, most of this activity has taken place without public consultation or public input. The assumption has been made by the powerful forces of governments and the corporate sector that the debate is over: "everyone" agrees to the commodification of water. And yet no one has given the world's citizens a real opportunity to debate the hard political questions about water: Who owns it? Should anyone own it? If water is privatized, who will buy it for Nature? How will it be made available to the poor? Who gave transnational corporations the right to buy whole water systems? Who will protect water resources if they are taken over by the private

sector? What is the role of government in the stewardship of water? How do those in water-rich countries share with those in water-poor countries? Who is the custodian of Nature's lifeblood? How do ordinary citizens become involved in the discussion?

This book presents some answers to these questions, answers based on a set of principles very different from those of the "Washington Consensus." We believe that fresh water belongs to the earth and all species and that no one has the right to appropriate it for personal profit. Water is part of the world's heritage and must be preserved in the public domain for all time and protected by strong local, national, and international law. At stake is the whole notion of "the commons," the idea that through our public institutions we recognize shared humanity and natural resources to be preserved for future generations.

We believe that access to clean water for basic needs is a fundamental human right; this vital resource cannot become a commodity sold to the highest bidder. Each generation must ensure that the abundance and quality of water is not diminished as a result of its activities. Great efforts must be made to restore the health of aquatic ecosystems that have already been degraded and to protect others from harm. Local and regional communities must be the watchdogs of our waterways and must establish principles that oversee the use of this precious resource.

Above all, we need to radically restructure our societies and lifestyles in order to reverse the drying of the earth's surface; we must learn to live within the watershed ecosystems that were created to sustain life. And we must abandon the specious notion that we can carelessly abuse the world's precious water sources because, somehow, technology will come to the rescue. There is no technological "fix" for a planet that has run out of water.

The debate over the wise and equitable use of the earth's water resources is far from over. In fact, it is just beginning. In this book, we tell the story of the world's growing fresh water crisis, the corporate assault on the water "commons," and the complicity of governments and international institutions in the theft of the world's fresh water. Most important, we show how ordinary citizens all over the world are engaging in a new form of citizen-based politics. They are rejecting the commodification of water and

taking back control, becoming "keepers" of the fresh water systems in their localities. These reformers and fighters are the heroes and heroines of the story. Their courage and foresight shine in our hearts. If we follow their example, we may be able to save our vital supplies of fresh water before it is too late.

Treaty Initiative

The Treaty Initiative to Share and Protect the Global Water Commons

We proclaim these truths to be universal and indivisible:

That the intrinsic value of the Earth's fresh water precedes its utility and commercial value, and therefore must be respected and safeguarded by all political, commercial, and social institutions,

That the Earth's fresh water belongs to the Earth and all species, and therefore must not be treated as a private commodity to be bought, sold, and traded for profit,

That the global fresh water supply is a shared legacy, a public trust, and a fundamental human right, and therefore, a collective responsibility,

And,

Whereas, the world's finite supply of available fresh water is being polluted, diverted, and depleted so quickly that millions of people and species

are now deprived of water for life and,

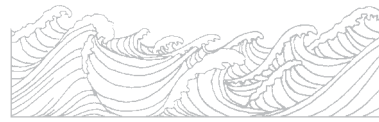
Whereas governments around the world have failed to protect their precious fresh water legacies,

Therefore, the nations of the world declare the Earth's fresh water supply to be a global commons, to be protected and nurtured by all peoples, communities, and governments of all levels and further declare that fresh water will not be allowed to be privatized, commodified, traded, or exported for commercial purposes and must immediately be exempted from all existing and future international and bilateral trade and investment agreements.

The parties to this treaty — to include signatory nation-states and Indigenous peoples — further agree to administer the Earth's fresh water supply as a trust. The signatories acknowledge the sovereign right and responsibility of every nation and homeland to oversee the fresh water resources within their borders and determine how they are managed and shared. Governments all over the world must take immediate action to declare that the waters in their territories are a public good and enact strong regulatory structures to protect them. However, because the world's fresh water supply is a global commons, it cannot be sold by any institution, government, individual, or corporation for profit.

— Written by Maude Barlow and Jeremy Rifkin and unanimously endorsed by the 800 delegates from 35 countries at the summit Water for People and Nature, Vancouver, July 8, 2001

Part I



The Crisis

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Red Alert

How the world is running out of fresh water

Water has been an important symbol in the legends and histories of many ancient cultures. Unlike people living in the urban, industrialized nations of the 21st century, most humans throughout history knew that their water resources could run out, and they developed a healthy respect for conserving whatever water they found. In biblical times, when Isaac returned to the land where his father Abraham had lived, the old wells he opened up were so important to life that they became a subject of dispute with other tribespeople. Later, Jacob's well was so highly prized and carefully protected that it was in use during the days of Jesus many centuries later.

Other societies, like the traditional Inuit and the early Mesopotamians, placed equal importance on the water that sustained the lives of their people. The Inuit depended largely on water-dwelling seals, fish, and walrus for their food, and their deity was a goddess of water, Nuliajuk. She ruled her realm with ferocious justice, and all of her power came from water. Nuliajuk gave the Inuit food from the sea and ice to build houses. When

she withheld her gifts, no one could live. In the strikingly different world of the early Mesopotamians, water was treasured for different reasons. Before this group moved to the fertile valleys of northern Iraq, they lived in the dry plains of the south. They did manage to harness water for their farms, but it was very scarce. That is why their water-god, Enki, became one of the most important deities in their pantheon.

Thousands of miles away, in China, the dangers of drought became a theme of one myth, in which a Great Archer shot down nine out of ten suns, to prevent the earth from drying out. Chinese tradition also held that water and other elements of the earth exist in a balance that should not be disturbed. If there was a disruption in the normal cycles of Nature, Chinese governors were called upon to alleviate the problem. They were expected to help make up for the harm done to crops by reducing taxes or by distributing grain from the country's storehouses. Today, the normal cycles of Nature are being disrupted by climate change and the abuse of almost every water system on earth. However, unlike governments that followed the Chinese tradition described above, our governments are abdicating their responsibility to protect and conserve water, and they are handing its management over to the private sector.

Corporate control of the world's water resources and distribution systems is a threat to the well-being of humans around the world because water is fundamental to life. All living ecosystems are sustained by water and the hydrological cycle. Ancient peoples, and those living closer to the forces of Nature in today's world, knew that to destroy water was to destroy self. Only modern "advanced" cultures, driven by acquisition and convinced of their supremacy over Nature, have failed to revere water. The consequences are evident in every corner of the globe: parched deserts and cities, destroyed wetlands, contaminated waterways, and dying children and animals.

Nature is not entirely benign, and like the water-goddess of the Inuit, it will not tolerate this abuse forever. The signs are all present. If we do not soon change our relationship to water and the ecosystems that sustain it, all our wealth and knowledge will be meaningless. We are as dependent on

fresh water for life as our ancient ancestors were. But many do not seem to be aware that this precious resource is disappearing. The clock is ticking, but they do not know it.

Finite Supplies

We'd like to believe there's an infinite supply of fresh water on the planet, and many of us have used water as if it would never run out. But the assumption is tragically false. Available fresh water amounts to less than one-half of one percent of all the water on earth. The rest is sea water, frozen in the polar ice, or water stored in the ground that is inaccessible to us. The hard news is this: humanity is depleting, diverting, and polluting the planet's fresh water resources so quickly and relentlessly that every species on earth — including our own — is in mortal danger. The earth's water supply is finite. Not only is there the same amount of water on the planet as there was at its creation; it is almost all the same water. Only a small amount may enter our atmosphere in the form of "snow comets" from the outer parts of the solar system. But even if the snow comet theory is correct, the speculated amount of water involved is so modest, it would do nothing to alleviate the shortage crisis.

The total amount of water on earth is approximately 1.4 billion cubic kilometers (about 330 million cubic miles). Canadian naturalist E.C. Pielou helps us visualize this statistic: if all the water on earth were solidified into a cube, each edge of the cube would be about 1,120 kilometers (about 695 miles) long, approximately twice the length of Lake Superior. The amount of *fresh* water on earth, however, is approximately 36 million cubic kilometers (about 8.6 million cubic miles), a mere 2.6 percent of the total. Of this, only 11 million cubic kilometers (about 2.6 million cubic miles), or 0.77 percent, counts as part of the water cycle in that it circulates comparatively quickly. However, fresh water is renewable only by rainfall. So in the end, humans can rely only on the 34,000 cubic kilometers (about 8,000 cubic miles) of rain that annually form the "runoff" that goes back to the oceans via rivers and groundwater. This is the only water considered "available" for human consumption because it can be harvested without depleting finite water sources.

Rain forms a crucial part of the hydrological cycle, the process through which water circulates from the atmosphere to the earth and back, from a height of 15 kilometers (about 9 miles) above the ground to a depth of 5 kilometers (3 miles) beneath it. Water that evaporates from the oceans and water systems of the continents goes into the atmosphere, creating a protective envelope around the planet. It turns into saturated water steams, which create clouds, and when those clouds cool, rain is formed. Raindrops fall on the earth's surface and soak into the ground, where they become groundwater. This underground water, in turn, comes back to the earth's surface in the form of sourcepoints for streams and rivers. Surface water and ocean water then evaporate into the atmosphere, starting the cycle anew.

Most of the earth's fresh water, however, is stored underground, just below the surface or deeper down. This is called groundwater, and it is 60 times greater in volume than the water that lies on the earth's surface. There are many types of groundwater, but the most important type for humans is "meteoric water" — moving groundwater that circulates as part of the water cycle, feeding above-ground rivers and lakes. Underground water reservoirs, which are known as aquifers, are relatively stable because they are secured in bodies of rock. Many of them are closed systems — that is, they are not fed by meteoric water at all. Wells and boreholes drilled into aquifers are fairly secure sources of water because they tap into these large reservoirs, but to be useful over time, an aquifer must be replenished with new water at approximately the same rate as the rate of extraction. However, around the world, people are extracting groundwater at rapid rates to supplement declining supplies of surface water.

Multiple Threats

All of the above-noted water sources are being taxed to their limit for multiple reasons. First, the world's population is exploding. Ten years from now, India will have an extra 250 million people and Pakistan's population will almost double, to 210 million. In five of the world's "hot spots" of water dispute — the Aral Sea region, the Ganges, the Jordan, the Nile, and the Tigris-Euphrates — the populations of the nations within each basin

are projected to climb by between 45 and 75 percent by 2025. By that year, China will see a population increase greater than the entire population of the United States, and the world will house an additional 2.6 billion people — a 57 percent increase over today's level of 6.1 billion. To feed this many human beings, says the UN's Food and Agriculture Organization (FAO), agricultural production will have to increase by 50 percent. In such a scenario, demand for fresh water will obviously explode. As Allerd Stikker of the Amsterdam-based Ecological Management Foundation explains, "The issue today, put simply, is that while the only renewable source of freshwater is continental rainfall . . . [a finite amount of water], the world population keeps increasing by roughly 85 million per year. Therefore the availability of freshwater per head is decreasing rapidly."

Furthermore, increasing numbers of people are moving to cities, where dense populations place terrible strains on limited water supplies and make delivery of sanitation services next to impossible. For the first time in history, as many people now live in cities as in rural communities. There are 22 cities in the world with populations of over 10 million inhabitants. By 2030, says the UN, the world's cities will have grown 160 percent, and twice as many people will live in cities as in the countryside.

Second, as a result of many factors, per capita water consumption is exploding. Global consumption of water is doubling every 20 years, more than twice the rate of human population growth. Technology and sanitation systems, particularly those in the wealthy industrialized nations, have allowed people to use far more water than they need. The average Canadian household now consumes 500,000 liters of water every year (about 130,000 US gallons); each toilet — and many homes have more than one — uses 18 liters of water per flush (about five US gallons). And enormous amounts of water are lost through leakage in municipal infrastructure in countries all over the world. Yet even with the explosion in personal water use, households and municipalities account for only 10 percent of water use.

Industry claims the next big chunk of the world's fresh water supplies, at 20 to 25 percent, and its demands are dramatically increasing. Industrial

use of water is predicted to double by 2025 if current growth trends persist. Massive industrialization is throwing off the balance between humans and Nature on many continents, especially in rural Latin America and Asia, where export-oriented agribusiness is claiming more and more of the water once used by small farmers for food self-sufficiency. Latin America and other Third World regions also host more than eight hundred free trade zones, where assembly lines produce goods for the global consumer elite, and these operations are another major drain on local water supplies.

Many of the world's growing industries are water intensive. It takes 400,000 liters (105,000 US gallons) of water to make one car. Computer manufacturers use massive quantities of de-ionized fresh water to produce their goods and are constantly searching for new sources. In the United States alone, the industry will soon be using over 1,500 billion liters (396 billion US gallons) of water and producing over 300 billion liters (79 billion US gallons) of wastewater each year. Originally thought to be a "clean" industry, high-tech has left a staggering pollution legacy in its short history. Silicon Valley has more Environmental Protection Agency (EPA) toxic Superfund sites than any other area in the U.S. and more than 150 groundwater contamination sites, many related to high-tech manufacturing. Close to 30 percent of the groundwater beneath and around Phoenix, Arizona, has been contaminated, well over half by the high-tech sector.

Irrigation for crop production claims the remaining 65 to 70 percent of all water used by humans. While some of this water use is for small farms, particularly in the Third World, increasing amounts are being used for industrial farming, which notoriously overuses and wastes water. These corporate farming practices are subsidized by the governments of industrialized countries and their taxpayers, and this creates a strong disincentive for farm operations to move to conservation practices such as drip irrigation. Much of the water usage that comes under this 65 percent heading should really be considered industrial, since modern factory farms have very little resemblance to community farms in any part of the world.

In addition to population growth and increasing per capita water consumption, massive pollution of the world's surface water systems has

placed a great strain on remaining supplies of clean fresh water. Global deforestation, destruction of wetlands, the dumping of pesticides and fertilizers into waterways, and global warming are all taking a terrible toll on the earth's fragile water systems. (See Chapter 2.) Another source of pollution is the damming and diversion of water systems, which have been linked to unsafe concentrations of mercury and water-borne diseases. And many such projects are being constructed throughout the world. The number of large dams worldwide has climbed from just over five thousand in 1950 to forty thousand today, and the number of waterways altered for navigation has grown from fewer than nine thousand in 1900 to almost five hundred thousand. In the northern hemisphere, we have harnessed and tamed three-quarters of the flow from the world's major rivers to power our cities.

At the same time, overexploitation of the planet's major river systems is threatening another finite source of water. "The Nile in Egypt, the Ganges in South Asia, the Yellow River in China, and the Colorado River in America are among the major rivers that are so dammed, diverted, or overtapped that little or no fresh water reaches its final destination for significant stretches of time," warns Sandra Postel of the Global Water Policy Project in Amherst, Massachusetts.

In fact, the Colorado is so oversubscribed on its journey through seven U.S. states that there is virtually nothing left to go out to sea. The flows of the Rio Grande and upper Colorado rivers are in danger of being reduced by as much as 75 percent and 40 percent, respectively, over the next century, and in 2001, for the first time in recorded history, the Rio Grande ceased to flow into the Gulf of Mexico.

Water levels of the Great Lakes have also hit record lows in recent years. In 2001, the water was more than a meter below its seasonal average in the Port of Montreal, and Lakes Michigan and Huron were down by 57 centimeters (about 22 inches). Water flows in the St. Lawrence River are greatly affected by the water tables of the Great Lakes, and the environmental watchdog group Great Lakes United is warning that one day, the St. Lawrence may no longer reach the Atlantic Ocean.

Drying Planet

A powerful new study by hydrological engineer Michal Kravčík and his team of scientists at the Slovakian NGO People and Water shows in minute detail just how profoundly humanity's activities are affecting its sources of fresh water. Kravčík, who has a distinguished career with the Slovak Academy of Sciences, has studied the effect of urbanization, industrial agriculture, deforestation, paving, infrastructure building, and dam construction on water systems in Slovakia and its surrounding countries. He has come up with an alarming finding. Destroying water's natural habitat not only creates a supply crisis for people and animals, it also dramatically diminishes the *actual amount* of fresh water available on the planet.

Kravčík describes the hydrological cycle of a drop of water. It must first evaporate from a plant, earth surface, swamp, river, lake, or the sea, then fall back down to earth as precipitation. If the drop of water falls back onto a forest, lake, blade of grass, meadow, or field, it can cooperate with Nature and return to the hydrological cycle because it can be easily absorbed into soil or forest. But if it falls onto pavement and buildings in urban areas, it is not absorbed into the soil and instead it heads out to sea. This means that less water exists in the ground and rivers and less evaporates from land. Therefore a landlocked country will receive less rain because the water that should have stayed there (absorbed into the soil or rivers or lakes) has fled out to the ocean.

Kravčík explains that "the water cycle can be balanced if the volume of water flowing [from] the rivers [on] the continents into oceans equals the volume of water evaporated from the oceans, which comes back to the continents through frontal systems." However, sometimes there is a decrease in the amount of water moving down from the earth's surface and into the ground. This is called a drop in capillary action and it can be caused by overbuilt landscapes. When rain hits pavement and buildings instead of forest and soil, it cannot be absorbed and sent underground. Instead, it swells both rivers and oceans. As a result, precious fresh water is converted to salt water.

Kravčík's team also found that as the earth's surface is paved over — denuded of forests and meadows, and drained of natural springs and creeks — less precipitation is staying in river basins and continental watersheds, where it is needed, and more is heading out to sea, where it becomes salty. It is as if the rain is falling onto a huge, low-lying roof, or umbrella, of pavement and treeless areas: everything underneath stays dry, and the water runs to the perimeter. The water's forest and meadow "domicile" would have trapped falling rain and snow, but when it hits paved areas and denuded land, it slips off and heads out to the ocean. Kravčík believes the destruction of water-retentive landscapes is a serious violation. "Right of domicile of a drop of water," he says, "is one of the basic rights."

To quantify this theory precisely, the scientists studied Kravčík's own country, Slovakia, a small nation in central Europe that has undergone intensive urbanization in a very short time. The once rural countryside has been transformed into a "modern" state and its water systems have been radically altered to accommodate this passage. The scientists found clear evidence that all human interference in Slovakia's watersheds has caused faster outflow of rainfall water from the land to the oceans. They were actually able to quantify how water supplies decreased because of additional roofing, paving, car parks, and highways. Every year in Slovakia, about 250 million cubic meters (about 9 billion cubic feet) of fresh water disappear — one percent of all the water in Slovakia's watersheds. And since World War II, annual precipitation in Slovakia has decreased by 35 percent! Because of overbuilt landscapes, there are fewer places for water to congregate — such as wetlands and ponds — from which it could evaporate and then fall back as rain, right near the land that needs it.

Terrifyingly, the authors have been able to make some speculations about what this means globally. The world is urbanizing and therefore being paved over at about the same rate as Slovakia. This means that the continents are losing about 1,800 billion cubic meters (about 6,400 billion cubic feet) of fresh water a year, thus causing the oceans to rise by 5 millimeters (about a fifth of an inch) annually. If this trend continues, over the next hundred years, the land mass will lose about 180,000 billion cubic meters of fresh water, which is approximately equivalent to the volume of water of the whole hydrological cycle.

Kravčík's scientists have also issued a dire warning about the growing number of what they call "hot stains" on the earth — places where previously existing water has already disappeared. In the near future, the "drying out" of the earth will cause drought; massive global warming, with its attendant extremes in weather; less protection from the atmosphere; increased solar radiation; decreased biodiversity; the melting of polar ice caps; submersion of vast territories; massive continental desertification; and eventually, in Michal Kravčík's words, "global collapse."

In addition, a study published by the Scripps Institution of Oceanography at the University of California, San Diego, in November 2001 (partially funded by NASA), found that particles of human-produced pollution may be weakening the earth's hydrological cycle as well. Tiny aerosol particles made up of sulfates, nitrates, fly ash, and mineral dust produced by fossil fuel combustion are cutting down the amount of sunlight penetrating the ocean. The resulting reduction in heat means that less water evaporates back into the atmosphere, and less evaporation means less rain. As well, say the 150 blue-ribbon scientists who conducted the research, these aerosol particulates are suppressing rain over polluted regions as they trap water droplets in their web.

Frantic Search

Not surprisingly, in the wake of the destruction of the world's surface fresh water supplies, communities, farmers, and industries are now aggressively seeking out the water supplies running free just under the earth's surface or held in deeper aquifer reservoirs. An estimated 1.5 billion people (about one-quarter of the world's total population) now depend on groundwater for their drinking water. Most areas of Asia, including the world's most populous countries — China and India — derive anywhere from 50 to 100 percent of their water supplies from groundwater. Some countries, such as Barbados, Denmark, and the Netherlands, are almost entirely dependent on this source. About one-third of the water used in France, Canada, and the United Kingdom is supplied by aquifers, while more than 50 percent of Americans are dependent on groundwater for their supplies. As a result of this explosive use of groundwater for day-to-day use around the world,

massive groundwater overpumping and aquifer depletion are now serious problems in most of the world's most intensive agricultural areas and they are reaching critical levels in many of the world's large cities.

Aquifers vary enormously in size. As naturalist E.C. Pielou explains, for a layer of groundwater to function as an aquifer, it must be large enough to store a useful volume of water and permeable enough to be extracted at an acceptable rate. Aquifers are either *confined* (covered by a layer of rock or other sediment through which water cannot escape upward) or *unconfined* (saturated, so the trapped water goes right up to the level of the water table and a pipe can therefore be drilled down into the aquifer without going through rock or hard sediment). The most common method of searching for groundwater sources is to drill test wells or boreholes into the ground to search for new supplies. While wells have been used for centuries, extensive pump extraction of groundwater is a phenomenon of the late 20th century because of the availability of electricity and inexpensive equipment.

In many parts of the world, pump irrigation was originally seen as a godsend because it allowed crops to be grown year-round. It also made the controversial Green Revolution of Asia possible. This was a massive experiment, carried out in many Third World countries, including India, to make sure that every acre of workable land produced higher yields. To do this, monoculture replaced biodiversity, and great amounts of pesticides and fertilizers were used. While food yield did increase dramatically, the Revolution is now largely discredited because it destroyed biodiversity, increased chemical pollution, and relied on intensive irrigation. The Green Revolution also pitted farmer against farmer as they competed for water that they once shared and conserved according to traditional methods. It rendered traditional community ways of dealing with floods, drought, and water allocation obsolete. And the Green Revolution's dependency on intensive water use, as well as fertilizers and pesticides, sowed the seeds of its own failure.

Another problem with groundwater is that it can't be seen; farmers don't know an aquifer is gone until it suddenly dries up. In addition, massive groundwater extraction not only causes depletion of finite aquifer reserves, it dramatically reduces the water table of the whole surrounding

area. When extraction exceeds recharge, the water also becomes progressively more expensive to pump and more contaminated with dissolved minerals. And crucially, because groundwater provides the principal source of water for streams, rivers, and lakes, these surface waters can also be depleted when aquifers are mined even if they do not dry up completely. River flows drop, ponds and marshes disappear, and salt water may invade emptied-out aquifers located in coastal areas. Water quality in the capital regions of Indonesia and the Philippines, for instance, has deteriorated sharply because of sea water intrusion. In some cases, aquifers emptied of water collapse in on themselves, especially if they are located under a large urban area. Thus, groundwater mining actually permanently reduces the earth's capacity to store water.

Pollution of underground water supplies has also become an issue as mining, manufacturing, and oil-extraction operations have expanded internationally. *World Resources*, a publication of the United Nations Environment Programme, reports that as Third World countries undergo rapid industrialization, heavy metals, acids, and persistent organic pollutants (POPs) are contaminating aquifers, often the only sources of local water.

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And in the Canadian province of Alberta alone, over 45 billion imperial gallons (about 204 billion liters) of water — much of it from aquifers — are pumped into oil wells every year to increase pressure in the reservoir and enhance production. This is enough fresh water to supply the seventy thousand residents of Red Deer for 20 years. Tragically, when the oil well is depleted, the water that remains behind is lost to people and Nature. It contains concentrated levels of minerals, as well as pollutants from the oil-drilling process.

Recently, oil companies and the Canadian government have invested heavily in the development of the Tar Sands — an oil sand reserve in northern Alberta the size of New Brunswick, which is estimated to contain about one-third of the world's remaining oil supplies, more than the reserves of Saudi Arabia. The process of separating the oil from tar sands requires huge volumes of water and is already diminishing stream and river flows in the area. Moreover, notes Canadian water expert Jamie
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Linton, the process contaminates water to such a degree that it must be stored indefinitely in tailing ponds. Further, the deeper oil sands must be recovered by drilling horizontal wells and injecting steam far underground. This method of extraction requires nine barrels of water to produce one barrel of oil. Scientists predict severe water shortages in the region as a result.

Coal-bed methane production also involves withdrawing massive volumes of highly saline groundwater from coal-seam aquifers. An average well dewaters 16,000 US gallons (about 60,000 liters) of groundwater per day, discharging the saline water into rivers and streams and destroying aquatic life. In Montana alone, there are plans to develop between 14,000 and 40,000 coal-bed methane wells in the next decade. A mid-range estimate of 24,000 producing wells would pump 345 million US gallons of water per day (about 1.3 billion liters per day) from underground water reserves, lowering aquifer levels by 34 feet (about 10 meters) in ten years and causing massive saline pollution of the surrounding area.

Exponential increases in water use such as this have led the World Resources Institute to issue the following dire warning: "The world's thirst for water is likely to become one of the most pressing resource issues of the twenty-first century. . . . In some cases, water withdrawals are so high, relative to supply, that surface water supplies are literally shrinking and ground water reserves are being depleted faster than they can be replenished by precipitation." Put in economic terms, instead of living on fresh water *income*, we are irreversibly diminishing fresh water *capital*. At some time in the near future, we will be fresh water *bankrupt*.

Parched America

Although North Americans usually think of water shortages as a Third World problem, they are recently coming face to face with the crisis within their own borders. Twenty-one percent of irrigation in the United States is achieved by pumping groundwater at rates that exceed the water's ability to recharge, which means that aquifers like the Ogallala in the American Midwest are being rapidly depleted. As a result, farmers all over the region are reeling from a lethal combination of severe drought and dried-up wells.

And the cost of losing American farmland because of the depletion of aquifers is over US$400 billion every year.

The Ogallala aquifer is probably the world's most famous underground body of water. It is the largest single water-bearing unit in North America, covering more than half a million square kilometers (about 190,000 square miles) of the American High Plains regions. It stretches from the Texas panhandle to South Dakota and is believed to contain about 4 trillion tons of water — 20 percent more water than Lake Huron in the Great Lakes. Although it is made up of fossil water — water locked deep underground for thousands of years with few sources of replenishment — it is being mined mercilessly by over 200,000 wells irrigating 3.3 million hectares (about 8.2 million acres) of farmland — one-fifth of all the irrigated land in the United States. At a withdrawal rate of 50 million liters (about 13 million US gallons) a minute, water in the Ogallala aquifer is being depleted 14 times faster than Nature can restore it. Since 1991, each year the water table in the aquifer has dropped by at least a meter (about three feet) — a huge amount when multiplied by the aquifer's area. By some estimates, more than half of its water is already gone.

The destruction of the Ogallala aquifer is probably America's most notorious headlong rush into water scarcity, but many other regions in the country are depriving themselves of water security as well. California, for instance, is in big trouble. Its aquifers are drying up, the Colorado River is strained to the limit, and the water table under California's San Joaquin Valley has dropped nearly 10 meters (about 33 feet) in some spots within the last 50 years. Overuse of underground water supplies in the Central Valley has also resulted in a loss of over 40 percent of the combined storage capacity of all human-made surface reservoirs in the state. California's Department of Water Resources predicts that, by 2020, if more supplies are not found, the state will face a shortfall of fresh water nearly as great as the amount that all of its towns and cities together are consuming today.

Population continues to explode in the deserts of the American Southwest, which are largely barren of water. More than eight hundred thousand people live in greater Tucson alone and four million in all of Arizona, a

tenfold increase in 70 years. Until recently, Tucson relied solely on aquifers for its water. But as overextraction increased, the depth of the wells grew from 150 meters to 450 meters (about 490 to 1,500 feet), and the city started importing supplies from the Colorado River and buying up local farms for their water, taking farmland out of production. Municipal development in Phoenix is occurring at a rate of an acre every hour, so it's small wonder that water tables have dropped more than 120 meters (about 390 feet) east of Phoenix. Projections for Albuquerque, New Mexico, show that if groundwater withdrawals continue at current levels, water tables will drop an additional 20 meters (about 66 feet) by 2020 and major cities in the region will go dry within 10 to 20 years.

Even in the suburbs around rainy Seattle, demand for water is outstripping supply, with predicted shortages in 20 years. In the much drier El Paso, Texas, all current sources of water are expected to be gone by 2030, and in northeast Kansas, the water shortage is so severe that state officials are discussing plans to build a pipeline to the already overtapped Missouri River. Similarly overtaxed is the huge sandstone aquifer lying under the Illinois-Wisconsin border, the source of water for millions of people, including the populations of Chicago and Milwaukee. A hundred years of pumping have mined this source relentlessly, and for decades, scientists have been monitoring the decline of the aquifer's water table, warning that, unless groundwater withdrawals are reduced, it will definitely run out of water in the foreseeable future.

Farther east, in Kentucky, more than half the state's 120 counties ran short of water during the summer of 2001. And on the Atlantic seaboard, Long Island takes water from a closed-basin aquifer rapidly being depleted and poisoned by industrial runoff. Meanwhile, the Ipswich River in Massachusetts is running thin, and Eastern cities, such as Philadelphia and Washington, whose water is notoriously bad, are searching farther afield for secure long-term water sources.

Like the Ogallala aquifer, the Florida aquifer system in the Southeast is also being mined far faster than it can naturally be replenished. Though it is about 200,000 square kilometers (about 76,000 square miles) in area and extends under several states besides Florida, its water levels are dropping dangerously low as its water is being extracted at a rate of 6.6 million liters

(about 1.7 million US gallons) per minute. The water table has plummeted so far in Florida that sea water has invaded its aquifers. Incredibly, Florida Governor Jeb Bush is championing a proposal to collect surface water and inject it, untreated and contaminated by all sorts of impurities, back into the depleted groundwater sources.

Desperate Mexico

South of the American border, the problem gets worse. Mexico City was once an oasis — an Aztec center called Tenochtitlan, which was literally an island city ringed by lakes and connected to the mainland by three causeways. Crisscrossed by abundant canals, aqueducts, dikes, and bridges, it was also a haven of floating gardens and baths. When the Spanish invaded in 1521, they tore down all the great Aztec buildings, destroyed the dikes, and using an endless supply of local slave labor, filled in and drained the lakes. Orders had been given that Mexico City, the capital of New Spain, should resemble a great Spanish city, not Venice. The protective forests surrounding the area were destroyed as well.

For five centuries, Mexico City's population remained static. The total in 1845 was only 240,000. Then it suddenly started to grow. It passed the million mark in 1930 and stands today at a breathtaking 22 million. Poor urban planning resulted in endless expansions of concrete, which covered the remaining drainage and free-flowing water, and an estimated 40 percent of its piped water leaks from a crumbling infrastructure built a hundred years ago. When the rain falls, it has nowhere to go but into the enormous subterranean system where it mixes with raw sewage and is pumped out of the city to irrigate the adjacent farmlands.

The pressure on the region's groundwater sources is understandably relentless. Mexico now depends on aquifers for 70 percent of its water and is extracting from aquifers 50 to 80 percent faster than the rate of regeneration. About a third of the city's water has to be pumped up to an area 2,300 meters (about 7,500 feet) above sea level, some from as far as 300 kilometers (about 180 miles) away. Mexico City is literally running out of water; experts are saying the city could go completely dry in the next ten years.

For decades, the city has also been sinking as underground water pockets have been replaced by air. The process, familiar to those living next to coal or oil extraction, is called subsidence. Mexico City was the first to experience the phenomenon as a result of water removal, because it sits on a porous, sponge-like subsoil. The more water people drink in Mexico City, the more they sink down into their foundations. Old sewer and water pipes are being crushed and architectural treasures are cracking and teetering. The city has sunk steadily into the mud for decades and is now subsiding at a rate of about 50 centimeters (about 20 inches) annually.

The crisis is not confined to the Mexican Valley. Years of drought in the northwestern state of Sonora have left the region dry as a bone, and Sonora's Batuc Reservoir, created when the Moctezuma River was dammed 35 years ago, is empty, eerily exposing a chapel and cemetery that were submerged at the time. North of Sonora, all along the Mexico-U.S. border, the export-processing zones known as the *maquiladora* employ millions of young Mexicans at slave wages, in unsafe, toxic conditions. Here, fresh water is so scarce that it is delivered weekly in many communities by truck or cart. Ciudad Juárez, growing at a rate of fifty thousand people a year, is running out of water, and the underground aquifer the city relies on has declined at about five feet (about one and a half meters) per year. At this rate, there will be no usable water left in 20 years.

Mid-East Crisis

Almost every country in the Middle East is facing a water crisis of historic proportions. In the Arabian Peninsula, groundwater use is nearly three times greater than recharge, and at the current rate of extraction, Saudi Arabia, which depends on aquifers for 75 percent of its water, is running toward total depletion in the next 50 years. In an attempt to become food self-sufficient, the country subsidized farmers to extract water, but this benefit came at a terrible cost. For every ton of grain produced, three thousand tons of water were used — three times the norm. Aquifer depletion curtailed this project, but not before the country's fresh water supplies were devastated. And in Iran, people are suffering through the worst water shortage in decades. The official IRNA news agency reports that Iran's

farms are short 1.2 billion cubic meters (about 39 billion cubic feet) of water. Severe droughts are intensifying the crisis.

In Israel, extraction has exceeded replacement by 2.5 billion cubic meters (about 88 billion cubic feet) in 25 years, and 13 percent of the country's coastal aquifer is contaminated by sea water and fertilizer runoff. According to its own officials, Israel will have a water deficit of 360 million cubic meters (about 12 billion cubic feet) by 2010, but already in July 2001, the Israeli government announced that the country faced "the deepest and most severe" water crisis ever as three years of drought have led the government to consider a nationwide ban on watering lawns. Water Commissioner Shimon Tal warned that the country would have to live "hand to mouth" until planned desalination plants begin operating and taking water out of the sea.

Israel gets about half of its water from Lake Kinneret (the Sea of Galilee), which is fed by the Jordan River, but the lake has experienced perilously low water levels in recent years and is beginning to be infiltrated by saline water. Most of the rest of Israel's water comes from two aquifers — the Mountain and Eastern aquifers — which, between them, supply most of the water for residents and farmers in the controversial settlement areas of the West Bank and the Huleh Valley. In the latter region, which was in Syrian territory before the 1948 war, massive farming operations based on aquifer mining have devastated water sources. In his book *Water*, Marq de Villiers describes how this came about. Wetlands were drained; groundwater tables began to drop; and streams and springs dried up. To deal with new salinity in the water, resulting from salt left behind when water systems were depleted, farmers switched to salt-resistant crops, but to no avail. The aquifers dried up and the earth subsided into the cavities left behind, just as it is doing in Mexico City. Some of the air pockets were so huge that whole houses were swallowed up and disappeared.

Palestine and Jordan are experiencing similar devastation. Palestine's Gaza Strip has one of the highest population growth rates in the world and relies almost exclusively on groundwater. However, salt water intrusion from the Mediterranean has been detected as far as a mile inland, and some experts predict that the country's groundwater will become entirely salinized. In Jordan, the sole source of surface water is the Jordan River, and

when Israel began diverting it for irrigation projects in the south of Israel, its water levels dropped. They are now only one-eighth of what they were 50 years ago, and this has forced Jordan to mine its limited aquifer systems to overcapacity. Groundwater in the country is now being used up 20 percent more quickly than the recharge rate. A tragic by-product of the diversion of the Jordan River is its impact on the Dead Sea. As Friends of the Earth, Middle East, explain, the surface of this body of water has dropped more than 25 meters (82 feet) in the last three decades and the drop is accelerating. The Dead Sea is dying, says the group. Its entire southern basin is dried up and has been transformed into an industrial site, and life-threatening sinkholes have appeared along its shoreline.

Elsewhere in Jordan, one underground water system with great symbolic meaning to Jordanians has been devastated. The Oasis of Azraq, deep in the Jordanian desert, has for centuries been a resting place for animals, migrating birds, and humans — a wondrous water-filled sanctuary fed at one time by more than ten subterranean springs. This oasis was so important to Jordan that it was named as an international wetland heritage site in 1977. However, desperate for water, the Jordanians started pumping from the Azraq 20 years ago, sending about 900 cubic meters (about 32,000 cubic feet) an hour to Amman, the capital. Within a few years, many wells had been built and were pumping almost three times that amount of fresh water, double what the basin can sustain. As Alanna Mitchell of the *Globe and Mail* reported, by 1993, the oasis was a dusty garbage dump, the land an open sore of deep fissures from which a searing heat arises.

Unfortunately, lessons from these terrible stories haven't changed humanity's behavior. Libya, which has used up all its conventional water sources and exposed its coastal aquifers to excessive mining, decided a decade ago to mine the sub-Saharan aquifer that lies under parts of Chad, Egypt, Libya, and Sudan. Known as the Nubian Aquifer, it is one of the world's most extensive. At the same time, at an estimated cost of over US$32 billion, Libya has hired a huge South Korean conglomerate to construct a 1,860-kilometer (1,000-mile) pipeline to take fresh water from the aquifers of the Kufra Basin in the Sahara Desert and use it to support the

farms and cities in the northern part of the country. Much of the project has been completed, and nearly one thousand wells now take water from beneath the desert.

Already, over one billion cubic meters (about 35 billion cubic feet) of water a year are being mined; when fully operational, the volume of water pumped from the aquifer will be 40 billion cubic meters (about 1,400 billion cubic feet) a year — equal to the flow of any great river. Libya's head of state, Moammar Gadhafi, variously calls this project the "Great Man-Made River" and the "Eighth Wonder of the World." At this rate, the aquifer could be empty in 40 to 50 years, affecting not only Libya, but all the countries around it.

China's "Miracle"

Perhaps the most disturbing reports of water crisis come from the country with the largest population on the planet. China has almost one-quarter of the world's population but only 6 percent of its fresh water. All over the country, wells are mysteriously emptying out, water tables are dropping, and rivers, streams, and lakes are drying up. As large industrial wells probe the ground ever deeper to tap the remaining water, millions of Chinese farmers have found their wells emptied. The western half of China is made up mostly of deserts and mountains, and the vast bulk of the country's 1.2 billion citizens live on several great rivers whose systems cannot sustain demands. For instance, in 1972, the Yellow River failed to reach the sea for the first time in history. That year it failed on 15 days; every year since, it has run dry for a longer period of time. In 1997, it failed to reach the sea for 226 days. The story is similar with all of China's rivers.

Water tables on the North China Plain — China's breadbasket — are dropping 1.5 meters (about 5 feet) a year, and northern China now has eight regions of aquifer overdraft. Four hundred of the country's six hundred northern cities are already facing severe water shortages, as is over half of China's population. And though water previously used by millions of farmers has been diverted to Beijing by deliberate government policy, the water table beneath the capital city has dropped 37 meters (about 120 feet) over the last four decades. The projected water crisis in Beijing is so

severe that experts are now wondering whether the seat of power in China will have to be moved.

These shortages come at a time when conservative estimates predict that annual industrial water use in China could grow from 52 billion tons to 269 billion tons in the next two decades, and when rising incomes are allowing millions of Chinese to install indoor plumbing with showers and flush toilets. The Worldwatch Institute predicts China will be the first country in the world that will have to literally restructure its economy to respond to water scarcity.

The Worldwatch Institute also warns that an unexpectedly abrupt decline in the supply of water for China's farmers could threaten world food security. In the near future, China will experience severe grain shortages because limited water resources are currently being shifted from agriculture to heavier industrial and urban users. Planners in China estimate that a given amount of water used in industry generates more than 60 times the cash value of the same water used in agriculture, and political leaders have responded by diverting more and more of China's rural water sources to its burgeoning industrial base. But when China faces shortfalls in its own grain production, the resulting demand for imported grain could at times exceed the world's available exportable supplies. China might be able to survive such shortages for a time because its booming economy and huge trade surpluses will give it the cash needed to buy grain. However, this rising demand will force the prices of imported grain to go up. And this, in turn, will create social and political upheaval in many major Third World cities and threaten global food security.

Spreading Disaster

The story has been repeated in many other countries and regions. Most African countries start with a limited water supply, which is then stretched even further by drought, population growth, and pollution. Africa, already home to the most sprawling desert in the world — the African Sahara — continues to suffer from desertification. Vast nonrecharging aquifers underlie this desert, but these are connected to the water mining project that Libya's Moammar Gadhafi has set up for his country. Current

depletion of these aquifers is estimated at 10 billion cubic meters (about 352 billion cubic feet) a year, and these rates will only increase as each stage of the project is completed.

According to Marq de Villiers, as many as 22 African countries fail to provide safe water for at least half their population: Guinea-Bissau, Guinea, Sierra Leone, Sao Tome and Principe, Mali, Niger, Nigeria, Cameroon, Congo, the Democratic Republic of Congo, Angola, Lesotho, Swaziland, Burundi, Mozambique, Madagascar, Uganda, Kenya, Ethiopia, Somalia, Djibouti, and Eritrea. However, it is India that has the highest volume of annual groundwater overdraft of any nation in the world. In most parts of the country, water mining is taking place at twice the rate of natural recharge, causing aquifer water tables to drop by 3 to 10 feet (about 1 to 3 meters) per year. Especially hard hit are the Punjab and Haryana states, India's breadbasket, and the northwestern state of Gujarat, where 90 percent of the wells have experienced a serious decline in water level. In the state of Tamil Nadu, groundwater tables have fallen as much as 99 feet (about 30 meters) in 30 years, and many aquifers have run dry. In the state of Rajasthan, the water system of the city of Jodhpur literally exploded when the water table beneath the city was drained dry. And in the Punjab and in the country of Bangladesh, the drop in the water table is even greater than China's, even though those places experience flooding every year. According to the International Water Management Institute, a quarter of India's grain harvest could be lost in the near future because of aquifer depletion.

Red Alert

According to the United Nations, 31 countries in the world are currently facing water stress and scarcity. Over one billion people have no access to clean drinking water and almost three billion have no access to sanitation services. By the year 2025, the world will contain 2.6 billion more people than it holds today, but as many as two-thirds of those people will be living in conditions of serious water shortage, and one-third will be living with absolute water scarcity. Demand for water will exceed availability by 56 percent.

Many of us who have lived most of our lives in the industrialized countries of the North may find it difficult to imagine running out of water. We have lived with steady supplies most of our lives and have used it lavishly. But at current rates of use, we will run short. At a time when we are on a rising curve in water use because of increasing industrialization, intensified farming, and population growth, water resources are being depleted at an accelerated rate. Aquifer overdrafts, massive urbanization, and unchecked pollution are withdrawing supplies from the world's water account, just when we need to be saving more. And as we shall see in the next chapter, wetland loss, toxic runoff, and other forms of environmental damage are also threatening the world's precious remaining supplies of water. There is simply no way to overstate the fresh water crisis on the planet today. The alarm is sounding. Will we hear it in time?