Instructions for Fall 2011 Freshman Composition
Final Examination Readings

Place your name on this packet of readings you download from the Writing Program website. You will return them to your instructor after you have finished writing the final essay examination.

No class time will be allotted for discussion of the readings, but you may, if you wish, discuss them outside of class with your classmates or other students enrolled in your freshman composition class.

Bring this packet with you to the final exam. You will use information from these sources to support your thesis. You may underline, highlight, and annotate the readings.

You may also bring a dictionary and your *Little Seagull Handbook*. However, you may not bring thesis statements, outlines, prewriting, or drafts in any form to exam.

If you use MLA documentation style to credit your sources, bring the pre-printed Works Cited page you downloaded with your reading packet and, when you have finished writing, place the page in the Blue Book in which you have written your final draft.

If you use APA documentation style to credit your sources, bring the pre-printed References page you downloaded with your reading packet and, when you have finished writing, place the page in the Blue Book in which you have written your final draft.

For Writing Program essays, MLA or APA are the only two acceptable documentation styles.

For the final essay exam, you will need two large-sized Blue Books. These are available at the bookstore. (If you have large handwriting, you may need a third Blue Book.) On the front cover of each book, write your name, your WRC course and section number, the date of your final, and your professor's name. Turn in both Blue Books to your professor before the final. You may use only Blue Books in which to write the final. On the day of the final, your professor will return the Blue Books to you so you can use them for the final essay. At the final, use one book for your prewriting and the other for your final draft. You will turn in both at the end of the final, along with the prompt.

Water Crisis

By World Water Council

While the world's population tripled in the 20th century, the use of renewable water resources has grown six-fold. Within the next fifty years, the world population will increase by another 40 to 50 %. This population growth - coupled with industrialization and urbanization - will result in an increasing demand for water and will have serious consequences on the environment.

Already there is more waste water generated and dispersed today than at any other time in the history of our planet: more than one out of six people lack access to safe drinking water, namely 1.1 billion people, and more than two out of six lack adequate sanitation, namely 2.6 billion people (Estimation for 2002, by the WHO/UNICEF JMP, 2004). 3900 children die every day from water borne diseases (WHO 2004). One must know that these figures represent only people with very poor conditions. In reality, these figures should be much higher.

Agricultural Crisis

Although food security has been significantly increased in the past thirty years, water withdrawals for irrigation represent 66 % of the total withdrawals and up to 90 % in arid regions, the other 34 % being used by domestic households (10 %), industry (20 %), or evaporated from reservoirs (4 %). (Source: *Shiklomanov, 1999*)

As the per capita use increases due to changes in lifestyle and as population increases as well, the proportion of water for human use is increasing. This, coupled with spatial and temporal variations in water availability, means that the water to produce food for human consumption, industrial processes and all the other uses is becoming scarce.

Environmental Crisis

It is all the more critical that increased water use by humans does not only reduce the amount of water available for industrial and agricultural development but has a profound effect on aquatic ecosystems and their dependent species. Environmental balances are disturbed and cannot play their regulating role anymore. (See Water and Nature)

Water stress results from an imbalance between water use and water resources. The water stress indicator in this map measures the proportion of water withdrawal with respect to total renewable resources. It is a criticality ratio, which implies that water stress depends on the variability of resources. Water stress causes deterioration of fresh water resources in terms of quantity (aquifer over-exploitation, dry rivers, etc.) and quality (eutrophication, organic matter pollution, saline intrusion, etc.) The value of this criticality ratio that indicates high water stress is based on expert judgment and experience (Alcamo and others, 1999). It ranges between 20 % for basins with highly variable runoff and 60 % for temperate zone basins. In this map, we take an overall value of 40 % to indicate high water stress. We see that the situation is heterogeneous over the world.

An Increase in Tensions

As the resource is becoming scarce, tensions among different users may intensify, both at the national and international level. Over 260 river basins are shared by two or more countries. In the absence of strong institutions and agreements, changes within a basin can lead to transboundary tensions. When major projects proceed without regional collaboration, they can become a point of conflicts, heightening regional instability. The Parana La Plata, the Aral Sea, the Jordan and the Danube may serve as examples. Due to the pressure on the Aral Sea, half of its superficy has disappeared, representing 2/3 of its volume. 36 000 km^2 of marin grounds are now recovered by salt.

Towards a Way to Improve the Situation

"There is a water crisis today. But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people - and the environment - suffer badly." World Water Vision Report

With the current state of affairs, correcting measures still can be taken to avoid the crisis to be worsening. There is a increasing awareness that our freshwater resources are limited and need to be protected both in terms of quantity and quality. This water challenge affects not only the water community, but also decision-makers and every human being. *"Water is everybody's business*" was one the key messages of the 2nd World Water Forum.

Saving Water Resources

Whatever the use of freshwater (agriculture, industry, domestic use), huge saving of water and improving of water management is possible. Almost everywhere, water is wasted, and as long as people are not facing water scarcity, they believe access to water is an obvious and natural thing. With urbanization and changes in lifestyle, water consumption is bound to increase. However, changes in food habits, for example, may reduce the problem, knowing that growing 1kg of potatoes requires only 100 litres of water, whereas 1 kg of beef requires 13 000 liters.

Improving Drinking Water Supply

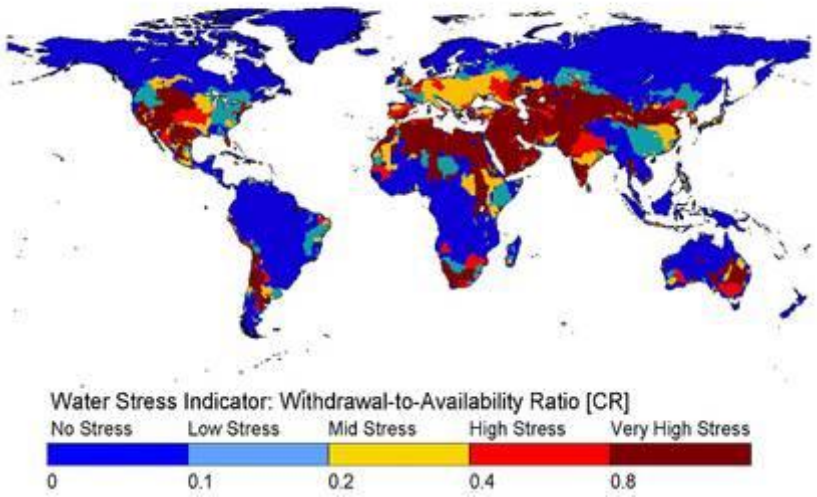
Water should be recognized as a great priority. One of the main objectives of the World Water Council is to increase awareness of the water issue. Decision-makers at all levels must be implicated. One of the Millennium Development Goals is to halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation. To that aim, several measures should be taken:

- guarantee the right to water;
- decentralize the responsibility for water;
- develop know-how at the local level;
- increase and improve financing;
- evaluate and monitor water resources.

Improving Transboundary Cooperation

As far as transboundary conflicts are concerned, regional economic development and cultural preservation can all be strengthened by states cooperating of water. Instead of a trend towards war, water management can be viewed as a trend towards cooperation and peace. Many initiatives are launched to avoid crises. Institutional commitments like in the Senegal River are created. In 2001, Unesco and Grenn Cross International have joined forces in response to the growing threat of conflicts linked to water. They launched the joint *From Potential Conflicts to Co-Operation Potential* program to promote peace in the use of transboundary watercourses by addressing conflicts and fostering co-operation among states and stakeholders.

The concept of Water Stress



Source: Water GAP 2.0 - December 1999

Global Water Shortage Looms In New Century

By University of Arizona Water Resource Research Center

When most U.S. citizens think about water shortages — if they think about them at all — they think about a local problem, possibly in their town or city, maybe their state or region. We don't usually regard such problems as particularly worrisome, sharing confidence that the situation will be readily handled by investment in infrastructure, conservation, or other management strategies. Whatever water feuds arise, e.g., between Arizona and California, we expect to be resolved through negotiations or in the courtroom.

But shift from a local to a global water perspective, and the terms dramatically change. The World Bank reports that 80 countries now have water shortages that threaten health and economies while 40 percent of the world — more than 2 billion people — have no access to clean water or sanitation. In this context, we cannot expect water conflicts to always be

Consider: More than a dozen nations receive most of their water from rivers that cross borders of neighboring countries viewed as hostile. These include Botswana, Bulgaria, Cambodia, the Congo, Gambia, the Sudan, and Syria, all of whom receive 75 percent or more of their fresh water from the river flow of often hostile upstream neighbors.

In the Middle East, a region marked by hostility between nations, obtaining adequate water supplies is a high political priority. For example, water has been a contentious issue in recent negotiations between Israel and Syria. In recent years, Iraq, Syria and Turkey have exchanged verbal threats over their use of shared rivers. (It should come as no surprise to learn that the words "river" and "rival" share the same Latin root; a rival is "someone who shares the same stream.")

More frequently water is being likened to another resource that quickened global tensions when its supplies were threatened. A story in The Financial Times of London began: "Water, like energy in the late 1970s, will probably become the most critical natural resource issue facing most parts of the world by the start of the next century." This analogy is also reflected in the oft-repeated observation that water will likely replace oil as a future cause of war between nations.

Global water problems are attracting increasing attention, not just at the international level, but also within the United States, in its popular press, in natural resource journals and as the subject of books. Former Sen. Paul Simon from Illinois recently authored Tapped Out: The Coming World Crisis in Water and What We Can Do About it. A book for the general, non-specialized audience, Simon's publication sounds an alarm about the approaching crisis. "Within a few years, a water crisis of catastrophic proportions will explode upon us — unless aroused citizens ... demand of their leadership actions reflecting vision, understanding and courage."

A prime cause of the global water concern is the ever-increasing world population. As populations grow, industrial, agricultural and individual water demands escalate. According to the World Bank, world-wide demand for water is doubling every 21 years, more in some regions.

Water supply cannot remotely keep pace with demand, as populations soar and cities explode.

Population growth alone does not account for increased water demand. Since 1900, there has been a six-fold increase in water use for only a two-fold increase in population size. This reflects greater water usage associated with rising standards of living (e.g., diets containing less grain and more meat). It also reflects potentially unsustainable levels of irrigated agriculture. (See sidebar.) World population has recently reached six billion and United Nation's projections indicate nine billion by 2050. What water supplies will be available for this expanding population?

Meanwhile many countries suffer accelerating desertification. Water quality is deteriorating in many areas of the developing world as population increases and salinity caused by industrial farming and over-extraction rises. About 95 percent of the world's cities still dump raw sewage into their waters.

Climate change represents a wild card in this developing scenario. If, in fact, climate change is occurring — and most experts now concur that it is — what effect will it have on water resources? Some experts claim climate change has the potential to worsen an already gloomy situation. With higher temperatures and more rapid melting of winter snow packs, less water supplies will be available to farms and cities during summer months when demand is high..

A technological solution that some believe would provide ample supplies of additional water resources is desalination. Some researchers fault the United States for not providing more support for desalination research. Once the world leader in such research, this country has abdicated its role, to Saudi Arabia, Israel and Japan. There are approximately 11,000 desalination plants in 120 nations in the world, 60 percent of them in the Middle East.

Others argue that a market approach to water management would help resolve the situation by putting matters on a businesslike footing. They say such an approach would help mitigate the political and security tensions that exacerbate international affairs. For example, the Harvard Middle East Water Project wants to assign a value to water, rather than treat rivers and streams as some kind of free natural commodity, like air.

Other strategies to confront the growing global water problem include slowing population growth, reducing pollution, better management of present supply and demand and, of course, not to be overlooked, water conservation. As Sandra Postel writes in her book, Last Oasis, "Doing more with less is the first and easiest step along the path toward water security."

Ultimately, however, an awareness of the global water crisis should serve to put our own water concerns in perspective. Whether our current activity is evaluating Arizona's Ground Water Management Act or, at a more personal level, deciding whether to plant water-conserving vegetation, the wiser choice would likely be made, if guided by an awareness that water is a very scarce and valuable natural resource.

Water Fights

By Nancy Macdonald on Monday, July 6, 2009 8:46am

Much of the world is desperately short of fresh water. Are future water wars inevitable?

Every few days, another farmer commits suicide in Australia's Murray-Darling Basin, the agricultural heartland. Many, according to Australian evolutionary biologist Tim Flannery, haven't had any water in almost four years—in places, the allocation of irrigation water has been cut to zero. Their farms have dried up, leaving a dusty, wind-whipped scrubland. Cattle bellow from hunger through the night. "Despair is an enormous problem," says Flannery. "There is no sign the situation will ever improve." Government has compiled a suicide watch list.

The world's flattest, driest and most vulnerable inhabited continent is gravely low on water. The "Mighty Murray"—Australia's Mississippi—is on the verge of collapse: in places, children can hop over it. National production of rice has fallen from a million tons annually to 21,000 tons last year, contributing to soaring global food prices. Cotton and citrus are also crashing. The problem is now creeping into the cities. Earlier this year, the national water commissioner announced that, as of 2010, he could no longer guarantee security of supply of water for critical use to Adelaide, says Flannery, author of the acclaimed book *The Weather Makers*. "That's Australia's fifth-largest city." Two years ago, the prime minister urged Aussies to "pray for rain—literally, and without any irony."

Australians, proudly "sunburnt" according to the hackneyed national myth, have withstood long dry spells before. But the current seven-year drought has come to be known as "the big dry." It is the longest, hottest and most devastating in the country's history. To Flannery, Australia, the world's 15th-biggest economy, is a climate canary, learning first the hard lessons on the limits of water in an era of shifting weather patterns. He reckons the western U.S. may be hit next.

The crisis in Australia is an extreme version of shortages hitting the U.S. Southwest, Israel and North Africa, focusing attention on what may be the most immediate environmental crisis facing the world: shortages of water. Far more than oil, our societies run on water. And unlike oil, there is no substitute for it. Yet an increasing body of evidence suggests there simply isn't enough to support future population and economic growth, not to mention waste born of years of abundance in places like Canada, one of the world's biggest water consumers.

From Tofino to Tucson, hydrologists, limnologists and government officials are reporting similar climatic trends: a longer dry season, less snow, more rain and earlier spring melts. "Half the annual flow of the Fraser now occurs nine days early," says Steve Litke of the Fraser Basin Council, a Vancouver NGO that studies the health of the massive watershed—home to two-thirds of B.C.'s population. These shifting climate patterns are changing "where, when and how" water falls and flows, eroding our ability to manage water for large populations, says Meena Palaniappan, with the San Francisco-based Pacific Institute.

Take California: snowpack from the Sierra Nevada mountain range provides the bulk of its water. But even the most optimistic climate models are showing a 30 to 70 per cent reduction of the Sierra Nevada snowpack by the second half of the century. This year, snowfall in the mountain range was down to about two-thirds of normal. By 2050, California's population will

have grown to 60 million, up from 36 million today. The “exploding” human population in the U.S. Southwest and its shrinking clean water supply are clearly on two “colliding paths,” acknowledges Pat Mulroy, the outspoken head of the Southern Nevada Water Authority. She oversees Las Vegas, the most vulnerable metro area on the continent, still “very much in the throes of an ugly drought” now entering its ninth year.

By contrast, Canada, with 20 per cent of the world’s freshwater resources, and less than one per cent of its population, looks like the Saudi Arabia of water. China, for example, has less than half Canada’s supply and 40 times as many people. Still, scientists warn that Canada is facing a distribution problem: 80 per cent of the country’s water resources are locked in the north, while 80 per cent of the population is packed along the U.S. border. Freshwater is scarce in Manitoba, Saskatchewan and Alberta, says David Schindler, one of the country’s top water scientists. There, he adds, lakes were retreating even in the 20th century: the wettest century of the past millennium, according to tree-ring fieldwork done by the universities of Arizona and Regina. Schindler predicts a likely mid-century return to ’30s-era, “dust-bowl” conditions—yes, even in Manitoba, land of 100,000 lakes—noting a 30 to 85 per cent reduction in summer river flows in the previous 30 years.

As aquifers under Beijing, Delhi, San Antonio and dozens more cities with mushrooming populations dry up, some experts suggest the era of cheap, easy access to water is coming to an end. Palaniappan calls it “peak water”: the point when demand outstrips renewable supply, and resources trend ominously downward. Humans, she says, are extracting and polluting it faster than it can be replenished. “In the developing world, more than 90 per cent of all sewage, and 70 per cent of industrial waste, is dumped untreated into surface water,” says Robert Sandford, Canadian chair of the UN Water for Life initiative, noting that 75 per cent of the river water flowing through China’s cities is unfit for drinking or fishing. This summer, Lake Mead, the largest reservoir in the U.S., which supplies nearly all the water for Las Vegas, fell to 43 per cent capacity. The Scripps Institute of Oceanography has given it 50-50 odds of surviving to 2021. Levels on the Sea of Galilee, the largest freshwater source in Israel—locked into year five of a devastating drought—have fallen to within inches of the “danger line.” Last year, Atlanta came within 90 days of running out of water.

The economic impact of water scarcity is grim: in the past two years, new power plants in four U.S. states, as well as several dozen commercial and residential development projects in California, have been cancelled because developers weren’t able to secure long-term water supplies. This summer, as California approaches its fourth year of drought, up to 30,000 workers will be laid off in its 650-km-long Central Valley, the country’s agricultural engine. Economic losses could top a half-billion dollars. In Australia, they’ve surpassed $20 billion.

As droughts and crises multiply, academics have begun grappling with the darker question of whether such shortages will push citizens—and even countries—into hostile factions of water-rich and water-poor. By mid-century, some of the world’s most populous, troubled regions are predicted to be dangerously water-scarce, including southern and central Asia, the Middle East and northeast Africa. This spring, a landmark report compiled by 24 UN agencies warned of a near future marred by war and conflict over water, sparked by so-called water bankruptcies.

But while it is newly popular to suggest the world’s next resource wars will be fought over water, and not oil, researchers at Oregon State University have found reason for optimism. Of the 1,831 documented disputes over freshwater resources in the last 50 years, 67 per cent were co-operative, while only 28 per cent resulted in conflict. The Indus Commission, a water sharing treaty between India and Pakistan, not only survived two wars, but, in the middle of one, India made treaty payments to Pakistan, says study

author Aaron Wolf. Shared water can act like an “elixir,” bringing warring sides to the table to co-operate, he says.

Often, however, this looks like “asymmetrical co-operation,” where terms are dictated by the stronger side, says former water engineer Mark Zeitoun, who teaches international development in Britain. Consider the Nile basin, often cited as an example of multilateral co-operation over shared water resources. A 1959 agreement grants Egypt 87 per cent of the river’s waters, and Sudan the remaining 13 per cent. Ethiopia, whose highlands supply 86 per cent of Nile water, receives nothing (Egypt has threatened to bomb Ethiopia should it attempt to build a dam). After a decade of “co-operation” under the auspices of the CIDA-funded Nile Basin Initiative, regional hegemon Egypt retains its 87 per cent stake. Ethiopia still gets nothing.

Tensions are rising as shortages intensify, says Zeitoun, noting simmering water conflicts along the Tigris and Brahmaputra, and intra-state conflicts in China’s Yellow Basin and the Basra region of Iraq. Two Pakistani provinces, Punjab and Sindh—the last in line for the Indus water before it reaches the sea—are routinely at odds over water. In Sindh, many fishers and farmers reliant on the rapidly declining delta ecosystem have simply given up and fled to cities—water refugees. In Darfur, where rainfall is down 30 per cent over 40 years, evaporating water holes and disappearing pasture helped push farmers and herders into civil war.

History has clearly shown that we solve water shortages through trade and international agreements, and not by picking up a gun. The shortfalls that await us, however, have no historical precedent. You can’t buy water from a country that is afraid it is not going to have enough for its own people.

In Texas, Drought Feels Like Another Dust Bowl

By Rick Jervis, *USA TODAY*

Posted 9/13/2011 12:20:36 AM

The rolling pastures surrounding this West Texas city usually are green and verdant, chock-full of roving herds of sheep and cattle grazing on a seemingly endless supply of grass.

These days, acre after acre is yellowed and inedible from a withering lack of rain. Wide patches are scorched black from where wildfires mauled them, and highway bridges span dry, empty riverbeds. There are few visible sheep or cattle, many having been sent to slaughter rather than being left to starve in the barren fields.

"It's just burnt up," says Jim Hughes, 68, a local cattle rancher who has lost 7,000 acres of his property to wildfires and sold off most of his herd. "It's the worst I've ever seen it."

As parts of the northeastern United States recover from historic flooding, Texas is suffering the worst one-year drought in its history. The state has received just 7.33 inches of rain this year through August, the lowest amount in four decades, state climatologist John Nielsen-Gammon says.

Temperatures, meanwhile, have hit record highs: Texas' June-through-August average of 86.8 degrees was the hottest summer for any state in U.S. history, beating a record set by Oklahoma (85.2) in 1934, according to the National Weather Service.

The dearth of rain has wilted fields and led to destructive wildfires across the state.
In the Bastrop area, 25 miles east of Austin, recent wildfires killed two residents and destroyed 1,550 homes in less than a week -- far surpassing the statewide record of 436 in 2009. Across Texas, wildfires this year have burned a record 3.7 million acres -- an area about the size of Connecticut, according to the Texas Forest Service.

Most affected by the drought have been cattle and sheep ranchers, whose grazing fields have been scorched into arid brown parchment and who have sent their herds to slaughter in record numbers.

The drought so far has cost the state a record $5.2 billion in livestock and crop losses, according to the Texas AgriLife Extension Service at Texas A&M University.
Statewide water restrictions now prevent waitresses from pouring glasses of water for guests at restaurants unless requested, and force some residents to drive 10 miles or more to wash their cars in neighboring counties that have fewer restrictions on water use. Lawns haven't had a drink in months. Throughout Texas, residents pray for rain at church, at the dinner table, at nightly vigils and at funeral eulogies.

Still, no rain comes.

"Everything about this is historic and comparable to the Dust Bowl years," says Robert Dull, an assistant professor of geography and the environment at the University of Texas-Austin, referring to the severe drought and dust storms of the 1930s that forced mass migrations from Oklahoma and other states. "People made major life-changing decisions based on that event, just as they will with this."

Droughts and wildfires usually are phenomena that occur in faraway, rural corners of West Texas, Dull says. But last week, some of his students said their families had lost homes to the wildfires in nearby Bastrop, marking a disaster felt as much in urban centers as in rural areas.
"There's a psychological effect that will linger for years," he says.

Claiming Homes, Not Just Prairie

The stunned residents of Bastrop gathered at the city's convention center last week, checking maps to see whether their homes had survived the fires.
The fires near Bastrop destroyed the lumber business belonging to Deborah Shelton and her husband, Bo. She left her home after smelling smoke, carrying only her camera, her laptop and a suitcase full of clothes. She says she's not sure what they'll do next.

"We just don't know if it's worth rebuilding at this point," Shelton says.
The drought is a result of La Niña, a weather phenomenon that cools surface temperatures in the eastern Pacific Ocean and creates drier-than-normal conditions in the southern United States, Nielsen-Gammon says.

The drought stretches across swaths of New Mexico, Oklahoma and Kansas but is most acute in Texas.

Here, 80% of the state is experiencing "exceptional" drought, the most severe ranking, according to the U.S. Drought Monitor, produced by the National Oceanic and Atmospheric Administration (NOAA) and other agencies.

More bad news: NOAA scientists recently predicted that La Niña will return this winter, extending the drought through at least next summer.

No Refuge for Ranchers

In San Angelo -- considered the epicenter of the drought -- the dry conditions have hit ranchers the hardest.

Benny Cox, who owns the area's largest livestock auction, says he has sold record numbers of cattle and sheep, including calves and young cows that ranchers typically would keep for breeding. On a recent afternoon, his bins bustled with 4,500 cattle -- more than four times the norm. Although good for business in the short term, the selling of the younger cows will mean a lack of cattle production in coming years, Cox says.
"A lot of these people have completely destocked," he says. "I've never seen that before."
Bill Tullos, 88, has been culling cattle and sheep on his property west of San Angelo for seven decades. He took over the family ranch when he was 16, after his father's sudden death. He has worked the livestock every year since, except for four years spent flying B-17 bombers over Europe during World War II, he says.

Today, the ranch's 4,500 acres are burnt yellow and parched. He has had to sell all 80 of his cows, all 900 sheep and 500 of his 700 goats.

If it doesn't rain by spring, the business started by his grandpa in 1919 will end, he says.
"There's nothing here," Tullos says of his ranch's parched conditions. "This is the driest I've ever seen it."

Water Supply Threatened

Twenty minutes up the road in Robert Lee, Texas -- population 1,049 -- city leaders are facing an even greater problem: how to get enough water to residents.
Nearby Lake E.V. Spence, where the city gets its water, has dropped to dangerously low levels, Mayor John Jacobs says. At last reading, the reservoir was at less than 0.5% of its total capacity, he says.

The city brought in bigger pumps to pull the last drops from the lake, but the quality of the water has plummeted as the pumps reach nearer the bottom, Jacobs says. The city has applied for federal and state funds to pipe in water from a nearby town. But even that would be a temporary fix, he says. Robert Lee is running out of water.

"We're just hanging on, praying for rain," Jacobs says.
So are townsfolk elsewhere.

Every Thursday night, a few residents of Llano, 75 miles west of Austin, gather in the gazebo in the town square and pray.

It's a routine started by Ervin Light, pastor of the Llano Church of God of Prophecy, during the 2009 drought and ramped up again this year.

On a recent Thursday, 15 of the faithful met at the gazebo and split into two circles. They joined hands, squeezed their eyes shut and prayed. They prayed for an end to the wildfires, for the thinning deer and cattle, for neighbors who have lost homes.
And they prayed for rain.

The problem plaguing Texas is not so much shifting weather patterns as a lack of fervent faith from its residents, says Light, 67. More prayer could open up the skies, he says.
"When enough people get serious and do whatever it takes to get God's attention," Light says, "that's when we'll have our rain."

4

Emerging Water Shortages

By Lester Brown

AFRICA'S LAKE CHAD, ONCE a landmark for astronauts circling Earth, is now difficult for them to locate. Surrounded by Cameroon, Chad, Niger, and Nigeria--all countries with fast-growing populations--the lake has shrunk 96 percent in forty years. The region's soaring demand for irrigation water coupled with declining rainfall is draining dry the rivers and streams that feed the lake. As a result, Lake Chad may soon disappear entirely, its whereabouts a mystery to future generations.

The shrinkage of Lake Chad isn't unique. The world is incurring a vast water deficit--one that is largely invisible, historically recent, and growing fast. Because the deficit comes largely from aquifer over pumping, it is often discovered only when wells go dry.

This global water deficit is the result of demand tripling over the last half-century. The drilling of millions of irrigation wells has pushed water withdrawals beyond recharge rates, in effect leading to groundwater mining. The failure of governments to limit pumping to the sustainable yield of aquifers means that water tables are now falling in countries that contain more than half the world's population, including the big three grain producers--China, India, and the United States.

Beyond these traditional sources of water insecurity, climate change is now affecting water supplies. Rising temperatures are boosting evaporation rates, altering rainfall patterns, and melting the glaciers that feed rivers during the dry season. As the glaciers melt, they are threatening to convert perennial rivers such as the Ganges in India and the Yellow in China into seasonal rivers, increasing both water and food insecurity. With the earth's climate system and its hydrological cycle so intertwined, any changes in climate will alter the hydrological cycle.

The link between water and food is strong. We each drink on average nearly 4 liters of water per day in one form or another, while the water required to produce our daily food totals at least 2,000 liters--500 times as much. This helps explain why 70 percent of all water use is for irrigation. Another 20 percent is used by industry, and 10 percent goes for residential purposes. With the demand for water growing in all

three categories, competition among sectors is intensifying, with agriculture almost always losing. Though most people recognize that the world is facing a future of water shortages, not everyone has connected the dots to see that this also means a future of food shortages.

Water Tables Falling

Scores of countries are over pumping aquifers as they struggle to satisfy their growing water needs. Most aquifers are replenishable, but not all are. When most of the aquifers in India and the shallow aquifer under the North China Plain are depleted, the maximum rate of pumping will be automatically reduced to the rate of recharge.

Fossil aquifers, however, aren't replenishable. For these--the vast U.S. Ogallala aquifer, the deep aquifer under the North China Plain, or the Saudi aquifer, for example--depletion brings pumping to an end. Farmers who lose their irrigation water have the option of returning to lower-yield dry-land farming if rainfall permits. But in more arid regions, such as in the southwestern United States or the Middle East, the loss of irrigation water means the end of agriculture.

Falling water tables are already adversely affecting harvests in some countries, including China, which rivals the United States as the world's largest grain producer. A groundwater survey released in Beijing in August 2001 revealed that the water table under the North China Plain, an area that produces over half of the country's wheat and a third of its corn, is falling fast. Over pumping has largely depleted the shallow aquifer, forcing well drillers to turn to the region's deep aquifer, which isn't replenishable.

Falling water tables, the conversion of cropland to non-farm uses, and the loss of farm labor in provinces that are rapidly industrializing are combining to shrink Chinas grain harvest. The wheat crop, grown mostly in semiarid northern China, is particularly vulnerable to water shortages. After peaking at 123 million (metric) tons in 1997, the harvest has fallen, coming in at 105 million tons in 2007, a drop of 15 percent.

A World Bank study indicates that China is mining underground water in three adjacent river basins in the north--those of the Hai, which flows through Beijing and Tianjin; the Yellow, and the Huai, the next river south of the Yellow. Since it takes 1,000 tons of water to produce one ton of grain, the shortfall in the Hai basin of nearly 40 billion tons of water per year (one ton equals one cubic meter) means that when the aquifer is depleted, the grain harvest will drop by 40 million tons--enough to feed 120 million Chinese.

As serious as water shortages are in China, they are even more serious in India, where the margin between food consumption and survival is precarious. To date, India's 100 million farmers have drilled 21 million wells, investing some $12 billion in wells and pumps. In a survey of India's water situation, Fred Pearce reported in the New Scientist that "half of India's traditional hand-dug wells and millions of shallower tube wells have already dried up, bringing a spate of suicides among those who rely on them. Electricity blackouts are reaching epidemic proportions in states where half of the electricity is used to pump water from depths of up to a kilometer."

As water tables fall, well drillers are using modified oil-drilling technology to reach water, going as deep as 1,000 meters in some locations. In communities where underground water sources have dried up entirely, all agriculture is rain-fed and drinking water must be trucked in. Tushaar Shah, who heads the International Water Management Institutes groundwater station in Gujarat, says of India's water situation,

"When the balloon bursts, untold anarchy will be the lot of rural India."

India's grain harvest, squeezed both by water scarcity and the loss of cropland to nonfarm uses, has plateaued since 2000. This helps explain why India reemerged as a leading wheat importer in2006. A 2005 World Bank study reports that 15 percent of India's food supply is produced by mining groundwater. Stated otherwise, 175 million Indians are fed with grain produced with water from irrigation wells that will soon go dry.

As water tables fall, the energy required for pumping rises. In both India and China, the rising electricity demand from irrigation is satisfied largely by building coal-fired power plants.

Pakistan, a country with 164 million people that is growing by 3 million per year, is also mining its underground water. In the Pakistani part of the fertile Punjab plain, the drop in water tables appears to be similar to that in India. Observation wells near the twin cities of Islamabad and Rawalpindi show a fall in the water table between 1982 and 2000 that ranges from one to nearly two meters a year.

Iran, a country of 71 million people, is over pumping its aquifers by an average of 5 billion tons of water per year, the water equivalent of one third of its annual grain harvest. Under the small but agriculturally rich Chenaran Plain in northeastern Iran, the water table was falling by 2.8 meters a year in the late 1990s. New wells being drilled both for irrigation and to supply the nearby city of Mashad are responsible. Villages in eastern Iran are being abandoned as wells go dry, generating a flow of "water refugees."

Saudi Arabia, a country of 25 million people, is as water-poor as it is oil-rich. Relying heavily on subsidies, it developed an extensive irrigated agriculture based largely on its deep fossil aquifer. After several years of supporting wheat prices at five times the world market level, the government was forced to face fiscal reality and cut the subsidies. Its wheat harvest dropped from a high of 4.1 million tons in 1992 to 2.7 million tons in 2007, a drop of 34 percent.

In neighboring Yemen, a nation of 22 million, the water table under most of the country is falling by roughly 2 meters a year as water use outstrips the sustainable yield of aquifers. In western Yemen's Sana'a Basin, the estimated annual water extraction of 224 million tons exceeds the annual recharge of 42 million tons by a factor of five, dropping the water table 6 meters per year. World Bank projections indicate the Sana'a Basin--site of the national capital, Sana'a, and home to 2 million people--may be pumped dry by 2010.

In the search for water, the Yemeni government has drilled test wells in the basin that are more than a mile deep--depths normally associated with the oil industry--but they have failed to find water. Yemen must soon decide whether to bring water to Sana'a, possibly by pipeline from coastal desalting plants, if it can afford it, or to relocate the capital. Either alternative will be costly and potentially traumatic.

In Mexico--home to a population of 107 million that is projected to reach 132 million by 2050--the demand for water is outstripping supply. Mexico City's water problems are well known. Rural areas are also suffering. In the agricultural state of Guanajuato, the water table is falling by two meters or more a year. In the northwestern state of Sonora, farmers once pumped water from the Hermosillo aquifer at a depth of 10 meters. Today they pump from more than 122 meters. At the national level, 51 percent of all the water extracted from underground is from aquifers that are being over pumped.

Since the over pumping of aquifers is occurring in many countries more or less simultaneously, the depletion of aquifers and the resulting harvest cutbacks could come at roughly the same time. And the

accelerating depletion of aquifers means this day may come soon, creating potentially unmanageable food scarcity.

Scarcity Crossing National Borders

Historically, water scarcity was a local issue. It was up to national governments to balance water supply and demand. Now this is changing as scarcity crosses national boundaries via the international grain trade. Since it takes 1,000 tons of water to produce one ton of grain, as noted earlier, importing grain is the most efficient way to import water. Countries are, in effect, using grain to balance their water books. Similarly, trading in grain futures is in a sense trading in water futures.

After China and India, there is a second tier of smaller countries with large water deficits--Pakistan, Algeria, Egypt, and Mexico. The latter three already import much of their grain. With its population outgrowing its water supply, Pakistan too may soon turn to world markets for grain.

The Middle East and North Africa--from Morocco in the west through Iran in the east--has become the world's fastest-growing grain import market. The demand for grain is driven both by rapid population growth and by rising affluence, much of the latter from the export of oil. With virtually every country in the region pressing against its water limits, the growing urban demand for water can be satisfied only by taking irrigation water from agriculture.

Overall, the water required to produce the grain and other farm products imported into the Middle East and North Africa last year approached the annual flow of the Nile River at Aswan. In effect, the region's water deficit can be thought of as another Nile flowing into the region in the form of imported food.

It is often said that future wars in the Middle East will more likely be fought over water than oil, but in reality the competition for water is taking place in world grain markets. The countries that are financially the strongest--not necessarily those that are militarily the strongest--will fare best in this competition.

Knowing where grain deficits will be concentrated tomorrow requires looking at where water deficits are developing today. Thus far, the countries importing much of their grain have been smaller ones. Now we are looking at fast-growing water deficits in both China and India, each with more than a billion people.

As noted earlier, over pumping is a way of satisfying growing food demand that virtually guarantees a future drop in food production when aquifers are depleted. Many countries are in essence creating a "food bubble economy"--one in which food production is artificially inflated by the unsustainable mining of groundwater. At what point does water scarcity translate into food scarcity?

David Seckler and his colleagues at the International Water Management Institute, the world's premier water research group, summarized this issue well: "Many of the most populous countries of the world--China, India, Pakistan, Mexico, and nearly all the countries of the Middle East and North Africa--have literally been having a free ride over the past two or three decades by depleting their groundwater resources. The penalty for mismanagement of this valuable resource is now coming due and it is no exaggeration to say that the results could be catastrophic for these countries and, given their importance, for the world as a whole."

Water Scarcity Yields Political Stresses

We typically measure wellbeing in economic terms, in income per person, but water wellbeing is

measured in cubic meters or tons of water per person. A country with an annual supply of 1,700 cubic meters of water per person is well supplied with water, able to comfortably meet agricultural, industrial, and residential needs. Below this level, stresses begin to appear. When water supply drops below 1,000 cubic meters per person, people face scarcity. Below 500 cubic meters, they face acute scarcity. At this level people are suffering from hydrological poverty--living without enough water to produce food or, in some cases, even for basic hygiene.

The world's most severe water stresses are found in North Africa and the Middle East. While Morocco and Egypt have fewer than 1,000 cubic meters per person per year, Algeria, Tunisia, and Libya have fewer than 500. Some countries, including Saudi Arabia, Yemen, Kuwait, and Israel, have less than 300 cubic meters per person per year. A number of sub-Saharan countries are also facing water stress, including Kenya and Rwanda.

While national averages indicate an adequate water supply in each of the world's three most populous countries-China, India, and the United States--regions within these countries also suffer from acute water shortages. Water is scarce throughout the northern half of China. In India, the northwestern region suffers extreme water scarcity. For the United States, the southwestern states from Texas to California are experiencing acute water shortages.

Although the risk of international conflict over water is real, so far there have been remarkably few water wars. Water tensions tend to build more within societies, particularly where water is already scarce and population growth is rapid. Recent years have witnessed conflicts over water in scores of countries. Perhaps the most common of these is the competition between cities and farmers, particularly in countries like China, India, and Yemen. In other countries the conflicts are between tribes, as in Kenya, or between villages, as in India and China, or upstream and downstream water users, as in Pakistan or China. In some countries local water conflicts have led to violence and death, as in Kenya, Pakistan, and China.

One water flash point involves the way water is divided between Israelis and Palestinians. A United Nations report notes that "nowhere are the problems of water governance as starkly demonstrated as in the Occupied Palestinian Territories" Palestinians experience one of the highest levels of water scarcity in the world. But the flash point is as much over inequity in the distribution of water as it is over scarcity. The Israeli population is roughly double that of the Palestinians, but it gets seven times as much water. As others have noted, peace in the region depends on a more equitable distribution of the region's water. Without this, the peace process itself may dry up.

At the global level, most of the projected population growth of nearly 3 billion by 2050 will come in countries where water tables are already falling. The states most stressed by the scarcity of water tend to be those in arid and semiarid regions, with fast-growing populations and a resistance to family planning. Many of the countries high on the list of failing states are those where populations are outrunning their water supplies, among them Sudan, Iraq, Somalia, Chad, Afghanistan, Pakistan, and Yemen.

Although spreading water shortages are intimidating, we have the technologies needed to raise water use efficiency, thus buying time to stabilize population size. Prominent among these technologies are those for more water-efficient irrigation, industrial water recycling, and urban water recycling. Unless population can be stabilized in these countries, the continually shrinking supply of water per person will put still more stress on already overstressed governments.

THE NEW OIL

By Jeneen Interlandi and RyanTracy *Newsweek*

Should Private Companies Control Our Most Precious Natural Resource?

Sitka, Alaska, is home to one of the world's most spectacular lakes. Nestled into a U-shaped valley of dense forests and majestic peaks, and fed by snowpack and glaciers, the reservoir, named Blue Lake for its deep blue hues, holds trillions of gallons of water so pure it requires no treatment. The city's tiny population--fewer than 10,000 people spread across 5,000 square miles--makes this an embarrassment of riches. Every year, as countries around the world struggle to meet the water needs of their citizens, 6.2 billion gallons of Sitka's reserves go unused. That could soon change. In a few months, if all goes according to plan, 80 million gallons of Blue Lake water will be siphoned into the kind of tankers normally reserved for oil--and shipped to a bulk bottling facility near Mumbai.

From there it will be dispersed among several drought-plagued cities throughout the Middle East. The project is the brainchild of two American companies. One, True Alaska Bottling, has purchased the rights to transfer 3 billion gallons of water a year from Sitka's bountiful reserves. The other, S2C Global, is building the water-processing facility in India. If the companies succeed, they will have brought what Sitka hopes will be a $90 million industry to their city, not to mention a solution to one of the world's most pressing climate conundrums. They will also have turned life's most essential molecule into a global commodity.

The transfer of water is nothing new. New York City is supplied by a web of tunnels and pipes that stretch 125 miles north into the Catskills Mountains; Southern California gets its water from the Sierra Nevada Mountains and the Colorado River Basin, which are hundreds of miles to the north and west, respectively. The distance between Alaska and India is much farther, to be sure. But it's not the distance that worries critics. It's the transfer of so much water from public hands to private ones. "Water has been a public resource under public domain for more than 2,000 years," says James Olson, an attorney who specializes in water rights. "Ceding it to private entities feels both morally wrong and dangerous."

Everyone agrees that we are in the midst of a global freshwater crisis. Around the world, rivers, lakes, and aquifers are dwindling faster than Mother Nature can possibly replenish them; industrial and household chemicals are rapidly polluting what's left. Meanwhile, global population is ticking skyward. Goldman Sachs estimates that global water consumption is doubling every 20 years, and the United Nations expects demand to outstrip supply by more than 30 percent come 2040.

Proponents of privatization say markets are the best way to solve that problem: only the invisible hand can bring supply and demand into harmony, and only market pricing will drive water use down enough to make a dent in water scarcity. But the benefits of the market come at a price. By definition, a commodity is sold to the highest bidder, not the customer with the most compelling moral claim. As the crisis worsens, companies like True Alaska that own the rights to vast stores of water (and have the capacity to move it in bulk) won't necessarily weigh the needs of wealthy water-guzzling companies like Coca-Cola or Nestlé against those of water-starved communities in Phoenix or Ghana; privately owned water utilities will charge what the market can bear, and spend as little as they can get away with on maintenance and environmental protection. Other commodities are subject to the same laws, of course. But with energy, or food, customers have options: they can switch from oil to natural gas, or eat more chicken and less beef.

There is no substitute for water, not even Coca-Cola. And, of course, those other things don't just fall from the sky on whoever happens to be lucky enough to be living below. "Markets don't care about the environment," says Olson. "And they don't care about human rights. They care about profit."

In the developed world--America especially--it's easy to take water for granted. Turn on any tap, and it comes rushing out, clean and plentiful, even in the arid Southwest, where the Colorado River Basin is struggling through its 11th year of drought; in most cities a month's supply still costs less than premium cable or a generous cell-phone plan. Many of us have no idea where our water comes from, let alone who owns it. In fact, most of us would probably agree that water is too precious for anybody to own. But the rights to divert water--from a river or lake or underground aquifer--are indeed sellable commodities; so too are the plants and pipes that process that water and deliver it to our taps. And as demand outstrips supply, those commodities are set to appreciate precipitously. According to a 2009 report by the World Bank, private investment in the water industry is set to double in the next five years; the water-supply market alone will increase by 20 percent.

Unlike the villain in James Bond's Quantum of Solace who hatched a secret plot to monopolize Bolivia's fresh-water supply, the real water barons cannot be reduced to a simple archetype. They include a diverse array of buyers and sellers--from multinational water giants like Suez and Veolia that together deliver water to some 260 million taps around the world, to wildcatter oil converts like T. Boone Pickens who wants to sell the water under his Texas Panhandle ranch to thirsty cities like Dallas. "The water market has become much more sophisticated in the last two decades," says Clay Landry, director of WestWater Research, a consulting firm that specializes in water rights. "It's gone from parochial transactions--back-of-the-truck, handshake--type deals--to a serious market with increasingly serious players."

Eventually, Olson worries, every last drop will be privately controlled. And when that happens, the world will find itself divided along a new set of boundaries: water haves on one side, water have-nots on the other. The winners (Canada, Alaska, Russia) and losers (India, Syria, Jordan) will be different from those of the oil conflicts of the 20th century, but the bottom line will be much the same: countries that have the means to exploit large reserves will prosper. The rest will be left to fight over ever-shrinking reserves. Some will go to war.

Until recently, water privatization was an almost exclusively Third World issue. In the late 1990s the World Bank infamously required scores of impoverished countries--most notably Bolivia--to privatize their water supplies as a condition of desperately needed economic assistance. The hope was that markets would eliminate corruption and big multinationals would invest the resources needed to bring more water to more people. By 2000, Bolivian citizens had taken to the streets in a string of violent protests. Bechtel--the multinational corporation that had leased their pipes and plants--had more than doubled water rates, leaving tens of thousands of Bolivians who couldn't pay without any water whatsoever. The company said price hikes were needed to repair and expand the dilapidated infrastructure. Critics insisted they served only to maintain unrealistic profit margins. Either way, the rioters sent the companies packing; by 2001, the public utility had resumed control.

These days, global water barons have set their sights on a more appealing target: countries with dwindling water supplies and aging infrastructure, but better economies than Bolivia's. "These are the countries that can afford to pay," says Olson. "They've got huge infrastructure needs, shrinking water reserves, and money."

Nowhere is this truer than China. As the water table under Beijing plummets, wells dug around the city must reach ever-greater depths (nearly two thirds of a mile or more, according to a recent World Bank report) to hit fresh water. That has made water drilling more costly and water contracts more lucrative. Since 2000, when the country opened its municipal services to foreign investment, the number of private water utilities has skyrocketed. But as private companies absorb water systems throughout the country,

the cost of water has risen precipitously. "It's more than most families can afford to pay," says Ge Yun, an economist with the Xinjiang Conservation Fund. "So as more water goes private, fewer people have access to it."

In the U.S., federal funds for repairing water infrastructure--most of which was built around the same time that Henry Ford built the first Model T--are sorely lacking. The Obama administration has secured just $6 billion for repairs that the EPA estimates will cost $300 billion. Meanwhile, more than half a million pipes burst every year, according to the American Water Works Association, and more than 6 billion gallons of water are lost to leaky pipes. In response to the funding gap, hundreds of U.S. cities--including Pittsburgh, Chicago, and Santa Fe, N.M.--are now looking to privatize. On its face, the move makes obvious sense: elected officials can use the profits from water sales to balance city budgets, while simultaneously offloading the huge cost of repairing and expanding infrastructure--not to mention the politically unpopular necessity of raising water rates to do so--to companies that promise both jobs and economy-stimulating profits.

Of course, the reality doesn't always meet that ideal. "Because water infrastructure is too expensive to allow multiple providers, the only real competition occurs during the bidding process," says Wenonah Hauter, executive director of the nonprofit, antiprivatization group Food and Water Watch. "After that, the private utility has a virtual monopoly. And because 70 to 80 percent of water and sewer assets are underground, municipalities can have a tough time monitoring a contractor's performance." According to some reports, private operators often reduce the workforce, neglect water conservation, and shift the cost of environmental violations onto the city. For example, when two Veolia-operated plants spilled millions of gallons of sewage into San Francisco Bay, at least one city was forced to make multimillion-dollar upgrades to the offending sewage plant. (Veolia has defended its record.)

Even as many U.S. cities look toward ceding their water infrastructure to private interests, others are waging expensive legal battles to get out of such contracts. In 2009 Camden, N.J., sued United Water (an American subsidiary of the French giant Suez) for $29 million in unapproved payments, high unaccounted-for water losses, poor maintenance, and service disruptions. In Milwaukee a state audit found that the same company violated its contract by shutting down sewage pumps to save money; the move resulted in billions of gallons of raw sewage spilling into Lake Michigan. And in Gary, Ind., which canceled its contract with United Water after 12 years, critics say privatization more than doubled annual operating costs. "It ends up being a roundabout way to tax people," Hauter says. "Only it's worse than a tax because they don't spend the money maintaining the system."

Representatives of United Water point out that 95 percent of its contracts are in fact renewed and say that a few bad examples don't tell the whole story. "We are dealing with facilities that were designed and built at the end of World War II," says United Water CEO Bertrand Camus. "We have plenty of horror stories on our side, too." The Gary facility, to take one example, went private only after the EPA forced the public utility to find a more experienced operator to solve a range of problems. "Individual municipalities don't have the expertise to employ all the new technology to meet the new standards," Camus says. "We do."

The bottom line is this: that water is essential to life makes it no less expensive to obtain, purify, and deliver, and does nothing to change the fact that as supplies dwindle and demand grows, that expense will only increase. The World Bank has argued that higher prices are a good thing. Right now, no public utility anywhere prices water based on how scarce it is or how much it costs to deliver, and that, privatization proponents argue, is the root cause of such rampant overuse. If water costs more, they say, we will conserve it better.

The main problem with this argument is what economists call price inelasticity: no matter what water costs, we still need it to survive. So beyond trimming nonessential uses like lawn maintenance, car

washing, and swimming pools, consumers really can't reduce water consumption in proportion to rate increases. "Free-market theory works great for discretionary consumer purchases," says Hauter. "But water is not like other commodities--it's not something people can substitute or choose to forgo." Dozens of studies have found that even with steep rate hikes, consumers tend to reduce water consumption by only a little, and that even in the worst cases, the crunch is disproportionately shouldered by the poor. In the string of droughts that plagued California during the 1980s, for example, doubling the price of water drove household consumption down by a third, but households earning less than $20,000 cut their consumption by half, while households earning more than $100,000 reduced use by only 10 percent.

In fact, critics say, private water companies usually have very little incentive to encourage conservation; after all, when water use falls, revenue declines. In 2005 a second Bolivian riot erupted when another private water company raised rates beyond what average people could afford. The company had dutifully expanded the city's water system to several poor neighborhoods outside the city. But the villagers there, accustomed to life without taps, were obsessive water conservers and hadn't used enough water to make the investment profitable.

The biggest winners of a sophisticated water market are likely to be the very few water-rich regions of the global north that can profitably move massive quantities across huge distances. Russian entrepreneurs want to sell Siberian water to China; Canadian and American ones are vying to sell Canadian water to the Southwestern U.S. So far, such bulk transfers have been impeded by the high cost of tanker ships. Now, thanks to the global recession, the tankers' rates have dropped significantly. If the Sitka plan succeeds, other water-rich cities may soon follow.

But in between the countries that will profit from the freshwater crisis, and those that will buy their way out of it, are the countries that have neither water to sell nor money with which to buy it. In fact, if there's one thing water has in common with oil; it's that people will go to war over it. Already, Pakistan has accused India of diverting too much water from rivers running off the Himalayas; India, in turn, is complaining that China's colossal diversion of rivers and aquifers near the countries' shared border will deprive it of its fair share; and Jordan and Syria are bickering over access to flows from a dam the two countries built together.

So what do we do? On the one hand, most of the world views water as a basic human right (the U.N. General Assembly voted unanimously to affirm it as such this July). On the other, it's becoming so expensive to obtain and supply that most governments cannot afford to shoulder the cost alone. By themselves, markets will never be able to balance these competing realities. That means state and federal governments will have to play a stronger role in managing freshwater resources. In the U.S., investing as much money in water infrastructure as the federal government has invested in other public-works projects would not only create jobs but also alleviate some of the financial pressure that has sent so many municipal governments running to private industry. That is not to say that industry doesn't also have a role to play. With the right incentives, it can develop and supply the technology needed to make water delivery more cost-effective and environmentally sound. Ultimately both public and private entities will have to work together. And soon. Unless we manage our water better now, we will run out. When that happens, no pricing or management scheme in the world will save us.

Texas Drought Losses to Agriculture Approach $1.5 Billion

By Blair Fannin, *Texas AgriLife* May 18, 2011 3:33pm

Preliminary estimates of Texas drought losses have reached $1.2 billion and are expected to escalate higher this year as livestock producers continue to sell off herds and crop conditions deteriorate, according to economists with the Texas AgriLife Extension Service.

"Each day without rainfall is one in which crop and livestock losses mount," said Dr. David Anderson, AgriLife Extension livestock economist. "Even with the severity of the current drought, estimation of economic losses is difficult given that we are still early in the growing season."
Livestock losses due to drought are an estimated $1.2 billion from November 2010 through May. Those losses include increased feeding costs and lost value of wheat pasture grazing, Anderson said.

"Texas is the largest beef cow producing state in the U.S. with more than 5 million head," Anderson said. "More than 90 percent of the state's beef cows are located in counties categorized as being in severe to exceptional drought."

The ongoing drought has forced ranchers to start feeding hay earlier in the season and to increase the amount fed due to lack of pasture growth, Anderson said.

"This increased feeding cost over normal levels is a direct economic impact on the livestock producers," he said. "The sudden severe onset of the drought has forced livestock producers to purchase even more hay, driving up prices sharply."

The drought has been so severe that many stock tanks that provide water for livestock have become "dangerously low or dry," Anderson said.

"This requires even higher costs to haul water daily to meet livestock needs," he said.
The most recent **U.S. Drought Monitor** indicates 100 percent of the state with at least abnormally dry conditions and 82 percent classified in extreme and exceptional drought.

Dr. Mark Welch, AgriLife Extension grain marketing economist, said much of the state has yet to plant spring row crops, and there is still time for weather patterns to change.

"However, for wheat, cotton and grain farmers in Central and South Texas who have planted or are facing final planting deadlines, and ranchers supplemental feeding on short pastures, each day without rainfall is costly," he said.

Welch said assuming crop conditions of 2011 continue on their current track, this year's Texas wheat production is estimated to be 34 million bushels.

"This would come off 25 percent of planted acres and an average yield of 24 bushels," he said. "High wheat prices in 2011 will offset some of the revenue lost to poor wheat yields for those farmers who still make a crop."

The total value for the Texas wheat crop this year is currently $274 million, about half of the five-year average of $555 million, Welch said.

“The low harvested percentage is compounded by several factors in addition to the drought,” Welch said.

“Record-high calf prices increase the value of wheat for grazing, especially if grain production prospects are poor, and record high cotton prices offer incentives for producers to terminate poor stands of wheat in hopes of producing a high value cotton crop.”

Uncertainty remains in place for Texas’ cotton crop, said Dr. John Robinson, AgriLife Extension cotton economist.

“Given the regular occurrence of dry weather in West and South Texas, and the late planting date in West Texas, it’s not unusual to be facing uncertainty about the level and condition of cotton plantings in the state. As the West Texas crop is not usually planted until May, there’s still time for conditions to change.”

Corn and sorghum are lacking adequate topsoil moisture for seed germination and deeper subsoil moisture to sustain crops that are up. Nearly all of the districts in Texas have more than 90 percent of the acreage topsoil moisture rated either short or very short. Late-planted corn is susceptible to mold infestation and aflatoxin contamination (a fungus that affects corn).

"The impact of high levels of aflatoxin range from discounts in price to the requirement to destroy the grain altogether,” Welch said.

The following is a list of economic drought losses from 1998 through 2009 compiled by AgriLife

Extension economists:

- 2009 - $3.6 billion
- 2008 - $1.4 billion
- 2006 - $4.1 billion
- 2002 - $316 million
- 2000 - $1.1 billion
- 1999 - $223 million
- 1998 – $2.4 billion

The New York Times

Creating solutions to a water crisis

By Alice Rawsthorn

Published: Saturday, August 9, 2008

LONDON — LONDON: The first thing you see is shelf after shelf of plain glass bottles all containing different colored liquids. Some of the liquids are clear, and others whitish, yellowish, brownish, greenish, or almost black. The colors change daily, as does the consistency, and whatever is growing inside.

All of the liquids are exactly the same thing - water. To be specific, they are examples of the 1 percent of the world's water that is available - and deemed suitable - for human consumption. These samples are displayed at the start of "1% Water and Our Future," an exhibition at Z33, a design and art gallery in the Belgian city of Hasselt, which explores our relationship to water, and how design can help us to use it more responsibly and productively.

"There is growing concern about the scarcity of water, and the need to save it, but in many countries, it's still taken for granted as something that pours out of the tap," said Jane Withers, who co-curated the exhibition with Ilse Crawford. "People think of water as a clear, neutral product that always looks the same. It doesn't, because it's a living thing, as the samples show. We hope that once people realize this, they'll consider using water more pleasurably as well as more thoughtfully."

The underlying theme of the exhibition is that the current efforts to stave off the water crisis will have greater impact if we also grow to appreciate its special qualities, such as its playfulness and sensuality.

The blunt facts of the water crisis are depicted in a graphic installation created by Hjalti Karlsson and Jan Wilker of the New York graphic design studio karlssonwilker. Some 70 percent of the earth's surface consists of water, but only 3 percent of it is freshwater, and less than a third of that (the 1 percent in the exhibition's title) is drinkable. The amount of water we consume is increasing, whereas the supply of freshwater is static, which is why it's running out. More than a third of the world doesn't have enough water, and the situation is worsening.

Another crisis is looming in water disposal. A third of the world's population already has inadequate sanitation. Many cities in developing countries are expanding so fast that they are literally outgrowing their sanitation networks. In developed countries, most of the networks are now decrepit. Hence the chaos on London's roads while its 19th-century drains are replaced.

Patching up and enlarging existing sanitation systems isn't the solution, as we may not have enough water to supply them, given that we waste so much of it. Some 70 percent of the drinking quality water flowing into North American or European homes is flushed down the toilet or used for cleaning. Our water footprints - which include the water used to manufacture the things we consume, as well as the water we use ourselves - are increasing. The further a product, and everything used to make it, has to travel, the bigger its water footprint will be. A typical Belgian consumes 108 liters, or nearly 30 gallons, of water directly each day, and another 4,940 liters indirectly, including part of the 10 that are used to produce a sheet of A4 paper, 11,000 for a pair of jeans and 40,000 for a car.

What can we do about it? The exhibition, which is to tour in other cities after Hasselt, including a stint at Somerset House in London in 2010, suggests lots of possibilities. Some are political initiatives, such as the water-saving program adopted by the Spanish city of Zaragoza, which succeeded in reducing its citizens' water consumption to a third of the national average. Others are ideas developed by designers and artists to suggest how we can redefine our relationship to water, as well as to propose practical solutions to the crisis.

Some of them are being tested at Z33. Hanging outside the building is Rain Catcher, a giant raindrop-shaped device developed by the Spanish designer Jordi Canudas to add rainwater to the drainage system. Taking pride of place in the garden is Pig Toilet, an experimental dry sanitation project devised by the Dutch artists Atelier Van Lieshout. It combines a pigpen with a human toilet, the contents of which are eaten by the pigs, rather than being flushed away and wasting water. "It sounds disgusting, but it works," said Crawford. "In the 19th century there was a vigorous debate between the advantages of dry and wet sanitation systems. The urgh! factor is the reason why wet systems won, but dry sanitation was a perfectly workable solution."

More conventional (and less stomach-churning) proposals include the LifeStraw, a $5 portable device invented by the Swiss company Vestergaard Frandsen to purify water as it is sucked up through a straw. Another is the Aquaduct, a concept tricycle developed by the American design group IDEO, which carries water, and purifies it using a mechanism started by turning the pedals.

Other projects not only help to save water, but encourage us to use it more imaginatively. Some countries, such as Japan, Finland and India, have never lost their appreciation of water, notably by cherishing communal bathing as an important social ritual. But industrialized countries tend to treat it as a commodity, with quantity trumping quality even in water's most "luxurious" guises, such as enormous "luxury" baths and power showers.

A collection of antique water vessels from different countries shows how water has been used sparingly, but very effectively by cultures that value it. Crawford and Withers believe that the designers of today's water-saving systems can learn from them, as the Dutch designer Irene van Peer did when developing the Mahlangu hand-washing device. "Hand washing is still the first defense against disease in the developing world," said Crawford. "People in communities without running water can make the Mahlangu themselves by customizing a plastic water bottle. They can have 50 or 60 hand washes from one liter of water. One woman commented on how pleasant it felt to feel water splashing on her hands - something she'd never experienced before."

GeoScience World

Water Conservation, Efficiency, and Reuse

Henry Vaux Jr.

Global water scarcity is intensifying. Economizing on water use will be an important aspect of any effective response. Water recycling and reuse technologies offer possibilities for more extensive use of water, depending on cost. Institutional responses, such as the use of rational pricing and the creation of water markets or exchanges, promise to improve water-use efficiency. Consumer education is a simple and inexpensive means of economizing on water in the urban and agricultural sectors. Rationing is effective in managing short-term interruptions such as drought. Point-of-use technology will also offer opportunities for economizing on many water uses.

RECYCLING AND REUSE: THE ROLE OF TECHNOLOGY

The potential for water to be recycled and reused depends upon whether the initial use is consumptive or not. Consumptive use occurs when the use to which water is put entails a change from the liquid phase to the gaseous phase. Agricultural water use in which the water is evapotranspired by a plant is an example of consumptive use. When this occurs the water so used cannot be used further or reused. Nonconsumptive use does not entail a phase change and the water is available for subsequent use. Thus, in irrigated agriculture, water that is not evaporated or transpired and runs off the field may be available for further use. Industrial and household wastewaters are also examples of water that is not consumptively used. In some regions the potential addition to water supplies of recycled industrial and domestic wastewater may be significant. In the southwestern United States, for example, supplies could be augmented by 5–10% by recycling industrial and domestic wastewater. And, of course, in-stream water uses, such as to support navigation and environmental amenities, are also nonconsumptive.

The recycling and reuse of irrigation water occur both intentionally and unintentionally. Where water is expensive or otherwise scarce, irrigators have a strong incentive to use every drop to which they are entitled. Where soils are heavy and infiltration rates low, water tends to run off. Such runoff can be captured in tailwater pits and either pumped to the head of the same field for reuse or used elsewhere. Similarly, water that percolates deeply beyond the root zone is often a significant source of groundwater recharge. This latter example of reuse may be either intentional or unintentional.

The potential for recycling and reuse of industrial and household wastewater is governed by cost considerations, which are in turn a function of the quality of the wastewater itself. Thus, for example, the quantity of water diverted for industrial purposes in the United States declined significantly following enactment of national water-quality standards and discharge control. The explanation lay in the fact that once industrial firms had treated wastewater to achieve the quality required by discharge regulations, the additional cost of restoring the quality to the point where it could be reused was quite modest. Most firms found it economical to simply reuse their treated wastewater as feed water for their industrial processes.

Household and industrial wastewater that is discharged to centralized sewer systems can be recycled and reused depending upon the level of treatment and the costs. In countries such as the United States, where surface water–quality standards and discharge regulations are in place, wastewater from sanitary (and in

some cases, storm-water) sewers must be treated to meet these discharge standards. This water may sometimes be suitable for uses that do not require very high quality. For example, treated wastewater is often used for landscape and crop irrigation, for which little or no additional treatment is required.

Today, wastewater treatment technology has advanced to the point where household and industrial wastewater can be cleaned so as to meet the standards prescribed for household use. For example, the Orange County Water District, located in Southern California, produces significant quantities of water from wastewater, and this recycled water is recharged to local aquifers from which it is ultimately extracted to serve household needs. The district employs several technologies, of which the most advanced feature artificial membranes that are used in a reverse osmosis process to clean the water prior to direct injection into the underlying aquifer. These technologies are relatively costly and can be employed economically only under certain conditions.

The Orange County Water District of Southern California has been a pioneer in reclaiming wastewater for potable reuse. The filtration facilities shown in Figure 2 are part of a larger set of facilities that allow for direct injection of reclaimed water as well as percolation to the underlying groundwater. This example of wastewater recycling and reuse is economically attractive both because the cost of the least-cost alternative supply is relatively high and because the regional wholesale supplier offers subsidies to retail suppliers who develop alternative supplies in lieu of wholesale supplies (Mills 2010). The example illustrates the fact that recycling technologies now available are economical when alternative supplies are either costly or unavailable. Wastewater can be recycled in relatively simple and inexpensive ways, such as percolating it through the soil to underlying aquifers. This technique is frequently referred to as soil-aquifer treatment. More expensive technologies employ some combination of filtration, chemical treatment, and the use of synthetic membranes (Gregory et al. 2011 this issue). In this case, the treatment technology selected usually depends on the quality of water required (National Research Council 2008).

Water scarcity will continue to intensify, leading to higher costs for new or reallocated supplies. Simultaneously, the cost of advanced wastewater-treatment technology is likely to decline as new and better technologies are developed. Both of these trends will combine to increase the number and frequency of circumstances in which wastewater recycling and reuse will be attractive. In the arid and semiarid southwestern United States, available surface waters are now fully allocated among existing agricultural, environmental, municipal, and industrial uses. Recycled water represents the sole source of unallocated water that will be available to serve new or growing uses in the future.

OTHER ECONOMIZING METHODS

Education

Water use declines when consumers are knowledgeable about where their water comes from and how much they use. Indeed, it appears that the more consumers know about the origin, nature, treatment, and cost of the water resources on which they depend, the more careful and economizing they are about use. Bruvold (1988) showed that metropolitan consumers in California, who are well informed about the origin of their domestic water and the costs of moving and treating it, tend to economize on its use, often by as much as 15–20%. This analysis was extended to major communities in the western United States by Michelsen et al. (1999), who showed that such reductions tend to be pervasive. In major metropolitan areas, utilities attempt to educate people about where their water comes from, how supplies are affected by drought, the quality of their water supplies, and the impacts of the water treatment and disinfecting systems used.

Traditional methods of reporting water consumption make it difficult for consumers to understand how much they use. Frequently, the amount of water consumed, as reported on utility bills to which rates are applied, is reported in unspecified and undefined units. In these circumstances, most consumers have no understanding whatsoever of their consumption level. When billing information includes rates of consumption in familiar units, such as gallons per day or gallons per month, consumers have a much clearer understanding of consumption levels and tend to use less than those who lack this information. Another frequent and helpful practice is to provide information on past as well as current levels of consumption. For example, a monthly bill might contain clear information on the consumption during the month in question as well as during the same month a year earlier.

Educational measures such as these are low in cost and simple. They are helpful in obtaining initial reductions in water consumption, which seem to occur when people first become aware of their rate of consumption. They are also helpful in facilitating adaptation to drought conditions. This is particularly true when special pricing or rate rules are imposed during drought periods in an effort to reduce consumption. Consumer education is one of the least costly means of inducing economical use of water (Michelsen et al. 1999).

Rationing

One usually thinks of water rationing in terms of the developing world. Yet, intelligently designed rationing systems can be employed as water-economizing measures in developed countries as well. Rationing works best as a response to temporary shortages. Rationing over the longer term begets black markets, which can be difficult to identify and regulate. The regulations needed to enforce rationing over the long term are frequently cumbersome and often difficult to enforce, particularly with respect to the indoor use of water. Rationing is thus well suited to the management of drought situations. Successful rationing schemes usually involve restrictions on outdoor water use (such as irrigation of the landscape on even-numbered days) where violations and violators are easy to observe. In addition, voluntary rationing, which can include restrictions on bathing and other indoor water uses, has also been successfully employed as a drought-management tool. Water use for outdoor purposes declined substantially during the drought of 1987–1992 in California, for example.

Rationing is frequently practiced in irrigated agriculture where the quantities to be delivered each year may be dependent on precipitation levels. Early in the year, growers are given an indication of how much water is likely to be available. This permits some flexibility and allows growers to adapt by fallowing some land or switching to less-water-intensive crops. In recent years, great progress has been made in learning how to irrigate permanent crops when water is rationed (Fereres et al. 2003). In most instances, crop yield will be reduced but the quality of the yield will be protected. The rationing of irrigation water is more easily practiced over the long term because reduced water deliveries can be anticipated. It is obviously undesirable to ration household deliveries of water where basic needs for drinking, cooking, and sanitation may be jeopardized.

Point-of-Use Technology

Employing point-of-use technology that reduces water flow or hardware that otherwise reduces water use are other ways of economizing on water use. Thus, low-flush toilets, low-flow showerheads, and flow restrictors can reduce the quantity of water used for various household purposes. In the future, recycling technologies that employ separate plumbing may make the use of gray water attractive for household landscape irrigation. Although the opportunities for economizing on industrial water use are more limited

because of the current high level of recycling, some new point-of-use technologies may be very attractive to industry. This will be especially true where the costs of such technologies are outweighed by reduced water and wastewater treatment costs.

Point-of-use technology in agriculture can also result in significant savings. Closed-conduit irrigation technologies—sprinkler and drip irrigation—can overcome inherent water-use inefficiency in light soils, with the result that yields can be maintained or increased with a constant or reduced amount of irrigation water. Mulching techniques that reduce evaporation from the soil surface are also promising. Appropriate regimes of moisture-stressing crops—providing crops with less water than is optimal for their needs—are also important point-of-use technologies. Such regimes promote fruiting and fruit quality and often restrict vegetative growth that contributes nothing to crop productivity. Significant investment in the development of such technologies is being made, which should enhance the ability of growers to economize on water use.

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