American Museum of Natural History
New York City www.amnh.org

# water

## $H_20$ = Life

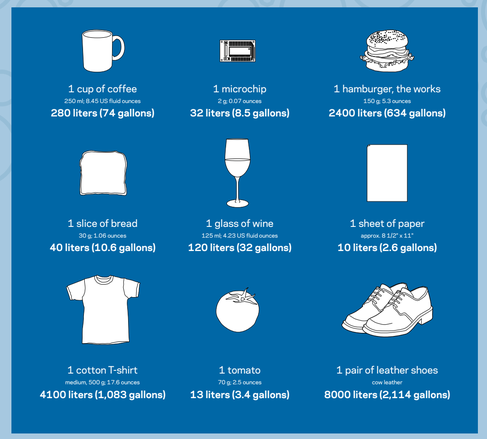
Water is among the most abundant substances on Earth's surface. Vast oceans cover our planet, while ice sheets and glaciers cap its poles and mountain peaks. All life depends on this water. And for humans, water is more than a biological necessity—it is also vital to human culture. Water inspires art and music, and it is central to rituals and ceremonies around the world.

Yet freshwater, the water we need to live, makes up only three percent of the world's water, and most of it is inaccessible. Too often we waste or pollute this precious resource—actions that threaten the survival of many of Earth's species. To ensure a future with healthy water for all life, we must become stewards of this precious resource.

# using water

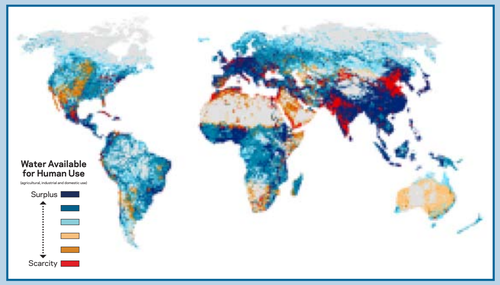
You've probably had a glass of water to drink today, taken a shower or washed some dishes. But even though there are more than six billion people on the planet, water use at home makes up only about eight percent of total water consumption. We pour by far the most—about 70 percent—into irrigating crops. Industry draws off the remainder, for example, in processes that cool machinery or rinse products.

By consuming so much of the world's fresh water, humans endanger animals, plants and other people. Smarter policies and practices can help to ensure there's enough water for all life on Earth.



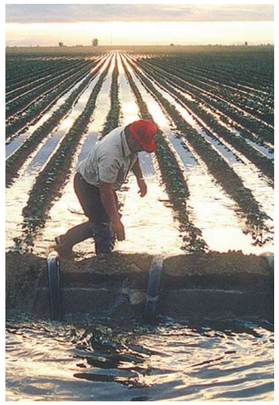

## Where's the Water?

How much water does it take to make a hamburger? Think about it. Not only do animals drink water, but growing their food—mainly grasses and corn—also consumes a lot of water. Look around: it takes water to produce nearly all the things you eat, wear and use.




## Where Water is Scarce

Both fresh water and human populations are unevenly distributed around the world. The red squares indicate densely populated areas where total water use by humans exceeds the renewable water supply. Densely populated areas with more water available than people need are shown in dark blue. Remarkably, scarcity and surplus can exist next to each other, even within one country. Regions with little or no human population are shown in gray.



AP/WIDE WORLD PHOTOS

## THIRSTY CROPS


Agriculture consumes 70 percent of the fresh water used by humans. With irrigation we can even grow crops in arid and semiarid places—but at a price. Depending on the method, irrigating these crops can waste tremendous amounts of fresh water and cause environmental harm.

GEORG GERSTER/PHOTO RESEARCHERS

## INDUSTRIAL USES

Worldwide, industry accounts for 22 percent of water use. Pulp and paper mills are among the most intensive consumers of water. Manufacturing and power plants not only take water in—they also discharge it. Wastewater is often laced with toxic chemicals or is warmer than the river, lake or ocean it flows into. Both factors can damage ecosystems and spoil water quality.


ALBERTO MARTIN/AGE FOTOSTOCK

## WATER AT HOME

How much water do you use? Americans consume more water than people in most other countries—an average of 573 liters (151 gallons) per person per day for domestic and municipal purposes. People in the United Kingdom, like most Europeans, live a more water-efficient lifestyle, using about 118 liters (31 gallons) per person per day. In Africa, where only one in four people has access to clean water that's piped indoors, water use is still lower. Ethiopians, for example, use on average 10 liters (three gallons) per person per day.

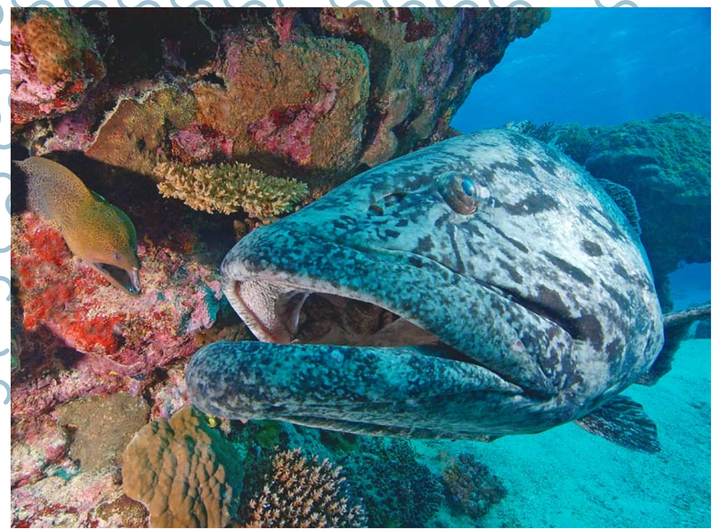
CORBIS/AGE FOTOSTOCK

## WATER FOR ALL

All species depend on water. Pacific salmon, for example, return to the freshwater streams where they were born, scaling waterfalls and other obstacles, to reproduce. But dams and reservoirs hinder their movements and change the flow of water. In addition, pollution and habitat destruction—in short, human changes to the environment—can prevent salmon from spawning. Dams, industry, agriculture and other human uses of water have endangered many freshwater animals and plants.

# life in and out of water

Can a fish crawl out of water? Are there animals that never drink? Since life on Earth began in water some 3.5 billion years ago, living organisms have evolved an amazing variety of techniques for surviving very different water conditions. Life exists wherever there's water—whether it's salty or fresh, hot or cold, abundant or scarce.



RODGER KLEIN/PETER ARNOLD, INC.

## SURVIVING IN SALT WATER

Surrounded by salty water, marine fish must take in enough seawater to stay hydrated while getting rid of excess salt. The potato grouper (*Epinephelus tukula*), for example, drinks seawater, but uses specialized cells in its gills to pump out excess salt. The fish's kidneys also release plenty of salt into its urine. Most land animals, including humans, can't drink seawater. If you do, you'll actually become dehydrated, because the volume of water needed to flush the excess salt from your body would be more than what you drank.

## LIFE. JUST ADD WATER

No bigger than a speck, tiny eight-legged creatures called tardigrades (Echiniscus testudo shown here) live in almost every habitat. When drought strikes, they essentially shut down their metabolism and shrivel up into a ball called a tun, waiting until water returns. They'll wait as long as it takes. Scientists have successfully rejuvenated tardigrades that had been dried out for more than 100 years. Tardigrades can also withstand oxygen deprivation, X-rays and extreme heat or cold.

ANDREW SYRED/PHOTO RESEARCHERS

JOE MCDONALD/VISUALS UNLIMITED

## DOESN'T DRINK THE WATER

Is it possible to survive without drinking any water at all? Kangaroo rats (*Dipodomys spectabilis* shown here) prove that it is. Some species of kangaroo rat get all the water they need from the food they eat. Their kidneys can recycle water more than four times as efficiently as human kidneys.

JOE MCDONALD/VISUALS UNLIMITED KENNETH FINK/PHOTO RESEARCHERS

## OUT OF THIN AIR

In most plants, the roots draw water and nutrients from the soil. But many species of orchids live high up in the trees. So how does a plant attached to the side of a tree get water it is so far from the ground? A special kind of root tissue, called velamen, absorbs moisture from rain or dew. To survive drier periods, many orchid species also have thick, bulblike stems that store excess water.

## HUMANS AND WATER

Humans cannot survive for long without fresh, clean water to drink. Our bodies are about 60 percent water by weight. And we lose water through perspiration, urination and exhalation—we breathe out water vapor. To replenish the body's water supply, a typical man needs about 3.7 liters (one gallon) each day and a typical woman about 2.7 liters (0.7 gallons). The water in food gives you about 20 percent of your daily needs, and beverages provide the rest.

MARK CLARKE/PHOTO RESEARCHERS

## FISH OUT OF WATER

By flipping a pair of well-muscled pectoral fins, a mudskipper can flop its way out of the water to look for food. On land, these amphibious fish can also use their tails to "skip" longer distances. Like most fish, a mudskipper breathes underwater using its gills. Out of the water, it carries oxygen-rich water in gill chambers, and it can absorb oxygen directly from the air through the lining of its mouth. The species shown here, Periophthalmus barbarus, is native to West Africa.

STEPHEN DALTON/MINDEN PICTURES

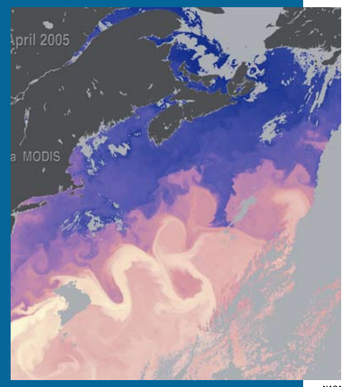
# blue planet

Water is the most familiar substance in our lives, and perhaps the most mysterious. It is so abundant on Earth that we call our home the blue planet. As a natural resource, water cycles endlessly through the environment; as a chemical compound, it acts like nothing else on Earth. Water is a shape-shifter, existing as liquid, solid and gas under everyday temperatures and pressures. Yet you wouldn't want water to be any less strange. If it were, life as we know it couldn't exist.

NASA

## WATER PLANET

Images from space show our planet for what it really is: a sphere whose surface is about 70 percent water. Most of it is salt water in Earth's oceans; less than three percent of the total is fresh. And most of that tiny percentage—the water capable of sustaining life outside of the oceans—is either locked up in glaciers or deep underground. Our lakes and rivers make up less than one-fiftieth of one percent of the water on our planet. And even that precious fraction occurs unevenly around the globe.




NASA

## DRIVING THE CLIMATE

Water has a remarkable ability to absorb and hold heat. As a result, ocean currents play a large role in Earth's climate. The broad ocean current called the Gulf Stream, which sweeps from Florida to the central Atlantic, transports warm water north from the Caribbean. Shown here in yellow and orange, the Gulf Stream surrenders a great heat load—twice the heat every day as all the coal mined on Earth in a year could generate. Eventually the cooled current sinks and flows south again.

## SURPRISING WATER

© ANTONIO VIZCAINO/AMERICA NATURAL

Water has many surprising traits, but perhaps the oddest is its ability to exist in three physical states—liquid, solid, and gas—under ordinary conditions. And each of those states has startling qualities of its own. For instance, we take it for granted that ice floats. But, chemically speaking, this is extremely strange: for most substances on Earth, the solid form is denser than the liquid. Water's unusual behavior is crucial to maintaining life in our oceans, lakes and rivers.

AP/WIDE WORLD PHOTOS

## COLD STORAGE

Only about two percent of Earth's total water exists as ice. Most occurs in the icecaps of the poles; the rest makes up the permanent glaciers that top the highest mountains. But this two percent is actually two-thirds of the planet's freshwater reserve. Seasonally melting snow feeds many of our great rivers and provides drinking water and habitats for vast numbers of the planet's species. With climate change, Earth's ice reserves are diminishing.

HEMERA/AGE FOTOSTOCK

## NOTHING IS LOST

Earth's water is in endless motion, on the planet's surface, below ground and in the atmosphere above. Lakes, rivers and oceans lose water to the air through evaporation. Plants draw water from the soil and release it to the air as well: the leaves in 0.4 hectares (one acre) of broad-leafed forest may release as much as 30,000 liters (8,000 gallons) of water a day to the atmosphere. All that water rises and—within days—falls back to Earth as rain or snow. Eventually, it finds its way to lakes, rivers and the sea.

C MICHAEL COLLIER


## CUTTING CANYONS

When water flows over relatively soft rocks, the effects can be dramatic. Buckskin Gulch, Utah, is 19 kilometers (12 miles) long and mostly less than three meters (10 feet) wide, making it the longest and deepest slot canyon in the American Southwest. Over millions of years, floodwaters have carved its characteristic swirls and curves. The cliffs rise 500 feet above the streambed where the Gulch's water joins the Paria River. The river then flows into the Colorado River at the Utah–Arizona border.

# water works I

Humans not only drink water—we put it to work. Massive dams generate power and supply cities with fresh drinking water. Miles upon miles of canals and irrigation ditches help grow the food we eat. We use water to make goods like paper and computer chips, to keep lawns green and for cooking and cleaning.

But our vast water infrastructure has costs as well as benefits. The effects of dams and water pollution, as well as channels and dredging, have endangered many species around the world. Can Earth's finite freshwater supply support an expanding human population, as well as the rest of the planet's species? Experts say that it can—but it all depends on how we manage and protect this critical resource.

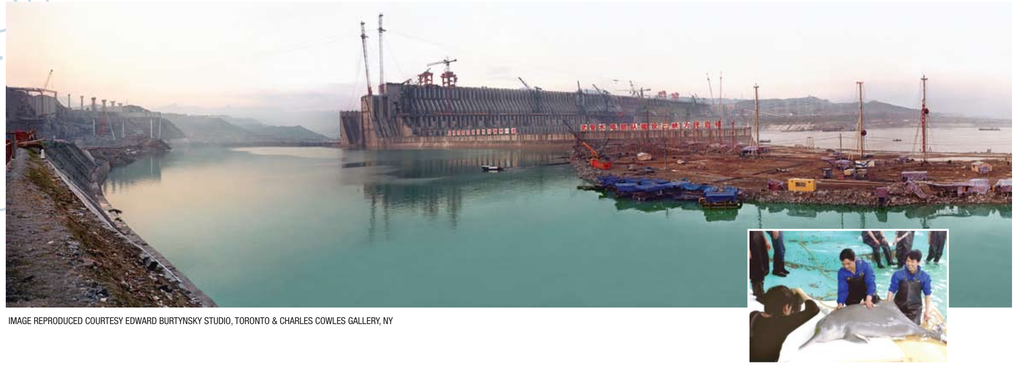
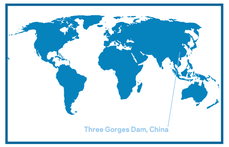


IMAGE REPRODUCED COURTESY EDWARD BURTYNSKY STUDIO, TORONTO & CHARLES COWLES GALLERY, NY

## BIGGEST DAM




The Three Gorges Dam on China's Yangtze River is the world's largest concrete structure, measuring about 2.3 kilometers (1.5 miles) across. With all its turbines running, it is projected to supply between two and 10 percent of China's energy needs. The dam may also help protect against floods downstream, but the destruction of river habitat is pushing several endangered species toward extinction. As more countries plan to build "mega-dams," critics point out the environmental and social costs of such projects.

BOBBY YIP/REUTERS/CORBIS

© MICHAEL COLLIER

ABOVE: YAN TIEJUN/AGE FOTOSTOCK
RIGHT: AP/WIDE WORLD PHOTOS

## FLOODED OUT

Behind Three Gorges Dam is the world's largest man-made reservoir—it is half the length of the state of California. To fill this huge basin, the Chinese government had to relocate more than 1.2 million people. The rising waters submerged cities, villages and irreplaceable farmland, as well as hundreds of historic landmarks and archaeological sites. The city of Zigui, with a population of 30,000, was dynamited in 2002 (above) after residents had been moved to a new city on higher ground.

## AN ANCIENT DAM SYSTEM


Today, we typically think of dams as huge, imposing constructions. But a large dam isn't the only effective way to manage a river. For centuries, residents of western China's Chengdu Plain suffered from devastating, unpredictable floods that took lives and ruined crops. Then in 256 BC, governor and engineer Li Bing designed a system of temporary dams, dikes and channels to control the local Min River while also providing a reliable water flow to farms. The basic design of the Dujiangyan project is still in use today.

## DRY LAND, WET CROP

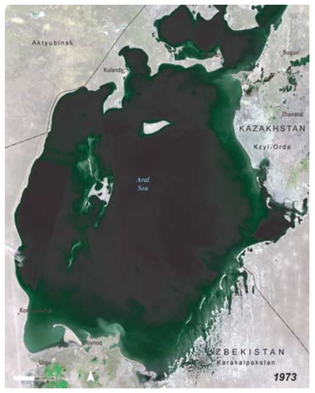

Think of rice farms and you probably imagine Asian hillsides drenched by monsoon rains. But more than two million tons of rice grow each year in California's Central Valley, which gets almost no rainfall during half the year. In fact, this sunny valley grows 25 percent of all of the fruits and vegetables eaten in the United States. With such huge demands for water, California's farmers rely on a vast network of federally funded dams, pumps and canals. If annual rainfall and snowfall decline as predicted by climate change models, growers may need to shift away from thirsty crops like rice.

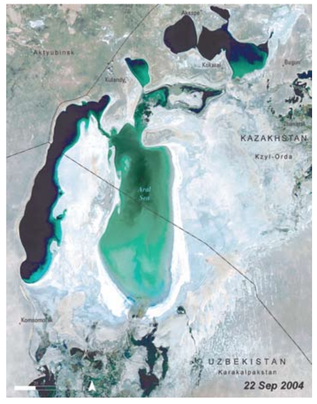
# water works II

JAMES STRACHAN/RISER/GETTY IMAGES

## IRRIGATION CIVILIZATION

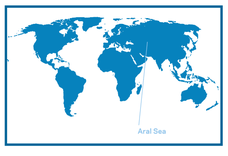

Mexico's Oaxaca Valley gets almost no rain for seven months of the year. Yet more than 2,000 years ago, the Zapotec people created one of the most successful farming civilizations in the Americas. An elaborate network of canals, dams and terraced fields transported and stored precious water to nourish a range of crops. The Zapotecs grew enough corn, beans, squash and other crops to support thousands of people in small villages and hilltop cities, such as Monte Albán (photo), their capital.




ABOVE: NASA/UNEP
RIGHT: NASA/UNEP

## A SHRINKING SEA




Once the world's fourth largest body of fresh water, the Aral Sea lost 80 percent of its volume and more than half its surface area between 1973 (above left) and 2004 (above right). The shrunken sea has lost dozens of bird and fish species, and local people suffer high rates of kidney and other diseases, likely resulting from exposure to pesticides used to grow the cotton.

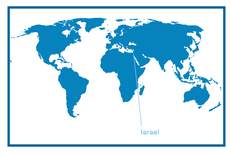
NASA/UNEP

## SUCKED DRY BY COTTON

Along the former shores of Central Asia's vast Aral Sea, rusted fishing boats sit not far from abandoned villages and piles of poisonous dust and salt. What happened? The two rivers that nourished the sea's fishing and tourist economies until the 1960s were diverted to irrigate enormous fields of cotton in a desert. More efficient irrigation is restoring some water flows. Another possible solution would be to switch to less thirsty crops like potatoes or sunflowers.

LEONARDO DIAS ROMERO/AGE FOTOSTOCK

## MORE CROP PER DROP




Despite other advances in agriculture, a surprising number of farmers still irrigate their crops the way people did 5,000 years ago, by running water down open canals and furrows. In hot climates, much of the water evaporates. In Israel, where there's hardly enough water to farm at all, engineers developed drip irrigation. A tube with specially designed nozzles drips precise doses of water directly to the roots, cutting water waste to nearly zero. About seven percent of U.S. farmland uses drip irrigation or similar techniques.

KRIS UNGER/VERDANT POWER

## UNDERWATER WINDMILLS


A field of turbines whirling beneath New York City's East River began supplying power, on a trial basis, to a nearby grocery store in 2007. The turbines spin when the tide flows up this estuary, then reverse direction and spin again with the outgoing tide. Similar systems are being tested in other rivers. Because tides are generated by the gravitational pull between Earth and the Moon, this power supply is reliable and inexhaustible.

# water everywhere

Water is among the most plentiful substances on Earth's surface. Between oceans, rivers and the rain, snow and hail that fall each day, Earth holds a nearly unimaginable amount of liquid water: about 327 quintillion gallons. And then there's the ice. Some of the places with the most water—the polar icecaps and glaciers—are frozen much of the year. Whether the water is liquid or frozen, present year-round or arriving in pulses with monsoons or hurricanes, humans and other species have adapted to life in all kinds of wet environments.

TOM MURPHY/WWI/PETER ARNOLD, INC.

## COLD-WEATHER BEAR

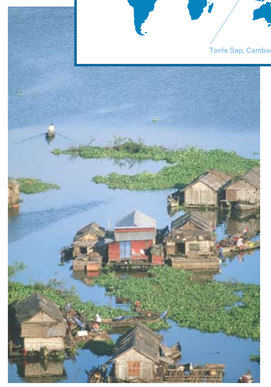
Polar bears (*Ursus maritimus*) spend much of the year on the Arctic sea ice hunting their favorite prey, ringed seals (*Phoca hispida*). With warm, camouflaging fur and a 10-centimeter (four-inch) thick layer of blubber, polar bears keep comfortable in frigid conditions. Their long sharp claws provide traction on the ice. But their frozen habitat is melting away as the climate warms, threatening their survival. Scientists have noticed a decline in the average polar bear weight, possibly because their season for hunting—and putting on fat—is shorter.

AP/WIDE WORLD PHOTOS


## LIVING ON ICE

Humans have inhabited the cold, icy Arctic environment for thousands of years. A dogsled team in today's Iditarod race follows an ancient network of hunting trails, rerouted in some places to avoid melting ice and snow. Many Native people living in the Arctic today still depend on hunting and fishing for subsistence. But warmer weather in recent years has made traveling over the sea ice more hazardous, and less ice has made seas rougher and more dangerous for fishing boats.

## A WELCOME FLOOD

MATINA/AGE FOTOSTOCK

Cambodia's Tonle Sap is the largest freshwater lake in Southeast Asia. In June, it becomes even bigger: filled by monsoon rains, the Tonle Sap River actually reverses direction and backs up into the lake, expanding the lake surface six-fold. About 80,000 people live on Tonle Sap in hundreds of villages built on stilts or bamboo rafts. The annual flooding creates a rich breeding ground for fish, and the Tonle Sap fisheries feed the majority of Cambodia's population. Tonle Sap also provides habitat for endangered water birds and threatened species such as the Mekong giant catfish (*Pangasianodon gigas*).

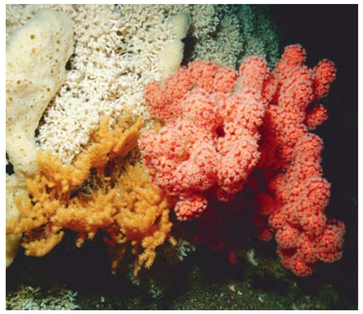
NASA

## HEAVY WEATHER

Typhoons, cyclones, hurricanes—depending on where severe tropical storms form, they take different names. But when these storms move from ocean to land, they bring a deluge to dry ground, as well as violent winds and powerful waves. Here, Hurricane Katrina swirls over the Gulf of Mexico on August 28, 2005. It hit the coasts of Louisiana, Mississippi and Alabama the next day, with devastating effects. Climate change may bring tropical storms that are more frequent and more intense.


## HIDDEN TREASURE

The floor of the deep ocean is home to amazingly diverse corals, adapted to darkness, high pressures and temperatures as cold as 4˚C (39˚F)—standard conditions under as much as 1,000 meters (3,300 feet) of water. These cold-water corals, which grow singly or in reefs, provide homes for an astonishing array of different lifeforms. But trawling for deep-sea fish and other creatures—dragging weighted nets across the ocean bottom—wipes away these fragile habitats. Once disrupted, the slow-growing corals might not rebound for hundreds or thousands of years, if ever.



FLORIAN GRANER/NATUREPL.COM

DINODIA/THE IMAGE WORKS

## WATER AND WAYS OF LIFE

Whether water is plentiful or scarce, it is as essential to human culture as it is to life. Every language has words for water, and for the ways water looks, sounds, feels and moves. Water inspires art and music, ritual and ceremony. Ritual bathing, for example, is central to many religions worldwide. Here, Hindu women in Mumbai, India, offer water to the setting sun during the festival of Chhath.

# not a drop

People who live where water is scarce have developed many clever ways of finding water: catching and keeping what little rain falls, drilling wells or—if they can afford it—extracting salt from seawater to yield freshwater for drinking or farming.

But water use has grown twice as fast as the world's population over the last century, straining water resources in ways both predictable and unexpected. More than a billion people lack access to safe drinking water. Even in the same city, a slum dweller may have access to a fraction of the water a person living in a better-supplied neighborhood uses. Water scarcity is not just an issue of too little rain—it is a problem of politics, infrastructure and sustainable use.

HAL BERAL/VISUALS UNLIMITED

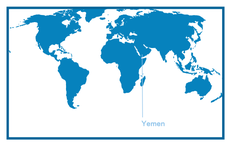
## WATER WISDOM


Where clean water is scarce, it is often women's work to fetch and carry water. But more than just gathering water, women manage the family's water—how it is stored, and how it is used for drinking, cooking, bathing and cleaning. When women are involved in planning and managing new water and sanitation facilities, their knowledge benefits the entire community. Access to safe drinking water and good sanitation improves everyone's health. Here, in Rajasthan, India, women fill their water jugs at a village pump.

## HARVESTING THE RAIN

For thousands of years people in arid regions have engineered channels, dams and storage pools in order to capture what rainfall there is. Large cisterns like this one in Yemen have steps down to the water level. In recent decades drilled wells have become more widely used in Yemen and around the world. But wells can turn brackish or run dry. Whether new technologies or traditional methods work better depends on the different conditions in different places.

C MORNA LIVINGSTON




## BIG GULP

This golf course stands out in the Nevada desert as a conspicuous consumer of water. Landscaping with drought-tolerant plants rather than emerald-green grasses, as well as limiting irrigation and recycling water can cut back water use. Cities in dry places must live within their local water budget for development and recreation in order to be sustainable over the long term.

JIM WARK/PETER ARNOLD, INC.


JUAN JOSE PASCUAL/AGE FOTOSTOCK

## GET THE SALT OUT


In some places where fresh water is scarce, people turn to the ocean as a source of water for drinking and agriculture. Desalination plants like this one in the Canary Islands remove salt and other minerals from seawater, usually by forcing it through a series of filters. Although seawater is plentiful, taking the salt out of it is expensive and energy intensive, and the waste product—a super-salty brine—may damage ecosystems. Even with new technologies for purifying water, conservation measures remain important.

C PLAYPUMP


## WATER PLAY

As children spin on this merry-go-round, they are also pumping water from a deep well called a borehole. The water flows to an elevated storage tank, shown here behind the children, where it is kept sanitary for drinking. More than 700 of these PlayPump® systems have been installed in rural areas in South Africa and several other sub-Saharan African countries. The children's energy can send as much as 1,400 liters (370 gallons) of water per hour into the tank, which also serves as a billboard for public health information.

## RIVER RESTORATION

Invasive plants—non-native species that spread rapidly because they have few natural enemies—are choking rivers and draining streams in drought-prone South Africa. Partly because of this, waterways once tapped for irrigation have become clogged with mud, and wetlands have been sucked dry, leaving them vulnerable to fire. South Africa's Working for Water program employs people to cut down and weed out the thirsty non-native species (top). In addition to yielding ecological benefits, selling the cut wood for use as firewood (bottom) or to build furniture helps involve the local community in the project.



© WORKING FOR WATER

© WORKING FOR WATER

# healthy water

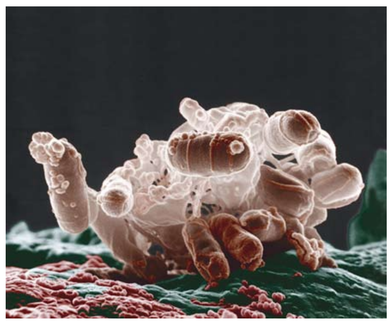
For as long as we have been human, we've been searching for sources of healthy water. Today, with human populations growing and climate changing, that search takes on a new urgency. We have new ways of purifying water, thanks to technology, but we have new ways of contaminating it, too. And now we know what our ancestors didn't: Earth's water is finite.

How do we make sure there is enough healthy water, not just for ourselves, but for everything on the planet? We could start by remembering that what we discard will eventually be in someone—or something—else's water. In the world of water, we're all downstream.

SEAN SPRAGUE/PETER ARNOLD, INC.

## NOT SAFE TO DRINK

Around the world more than a billion people lack access to safe drinking water, and even more live without adequate sanitation. These children in Kenya are collecting water that is likely contaminated with microorganisms that cause diarrhea. Worldwide, some 6,000 people die each day from diarrheal diseases—most of them children under the age of five.



ERIC ERBE/AGRICULTURE RESEARCH SERVICE/DEPARTMENT OF AGRICULTURE

## INVISIBLE WORLD

Every human body is full of useful bacteria that, among other things, help us digest food. Escherischia coli is one of them. Most E. coli are harmless, though there are some deadly strains. Still, the presence of this bacterium in water is a sign that the water supply has been contaminated with human waste. More than one billion people worldwide must drink water containing this or other—deadlier—microorganisms.

## TRUE VALUE

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Long considered unsightly and useless, wetlands have been steadily filled, farmed and developed throughout history. But recently we have come to recognize wetlands as a key piece of nature's water purification system and important wildlife habitat. Cattails and certain grasses, for example, can absorb pollutants. And microbes living on the roots of many wetland plants can digest heavy metals. In addition, when muddy runoff from a heavy rainfall gets caught in a wetland, sediment has a chance to settle, leaving the water relatively clear.

P. NARAYAN/AGE FOTOSTOCK

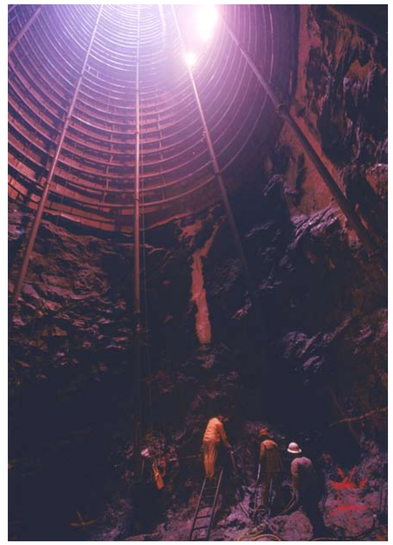
## CLEANSED AND RECLAIMED

In their search for clean water, some localities are taking a radical step. They're looking at a substance that was once a disposal problem—sewage—and reimagining it as a solution to water shortage. In the desert city of Windhoek, Namibia, reclaimed water makes up as much as 30 percent of the municipal supply, depending on the time of year. Reclaimed water—especially when used for drinking rather than agriculture—goes through many complex purification steps before being added to the drinking water supply.


## MESSAGE IN A BOTTLE

Bottled water sales are skyrocketing, up more than 50 percent in the past decade. Where safe drinking water is scarce, bottled water may be the only source of clean water. But it also has large hidden costs. Manufacturing the plastic bottle takes twice as much water as the bottle holds. Then there's the massive amount of plastic waste. And by some estimates the energy used each year to ship bottled water amounts to half a million gallons of oil. Water from a safe public supply is always less expensive than bottled water.

COLIN MONTEATH/AGE FOTOSTOCK



PETER ESSICK/AURORA PHOTOS

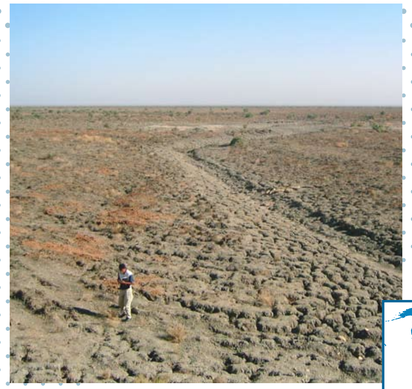
## WATER FOR THE FUTURE

Providing clean water is among a city's most crucial services. New York City delivers about 4.5 billion liters (1.2 billion gallons) a day to more than eight million residents, from reservoirs in a huge watershed extending more than 160 kilometers (100 miles) north and west of the city. Portions of this gigantic new tunnel (photo), among the largest engineering projects on Earth, have already begun delivering water.

# regenerating ecosystems

Natural freshwater systems are essential to life—and they're also very fragile. When we dam and divert water, we often transform these ecosystems so much that they no longer function. But there's good news: many aquatic systems, like wetlands, tend to be resilient. When water returns, species come back too, and life flourishes anew.

As we recognize the importance of wetland ecosystems, efforts to restore them are expanding worldwide. But, although regeneration is possible, it is costly and outcomes are not always certain. Even better—both ecologically and economically—would be to protect these ecosystems before they are disrupted.



CURTIS J. RICHARDSON/DUKE UNIVERSITY WETLAND CENTER


## MARSHES LOST

The Mesopotamian marshes, on the border of Iraq and Iran near the Persian Gulf, were once the largest and most productive wetlands in the Middle East and western Eurasia. Millions of birds and game animals, countless fish and about 500,000 people—the Ma'dan—called these wetlands home. In retaliation for a Ma'dan uprising during the 1991 Gulf War, then Iraqi President Saddam Hussein diverted the rivers that fed the marshes, poisoned the waters and burned the lush reed beds. More than 90 percent of the original marshes dried up and died.

CURTIS J. RICHARDSON/DUKE UNIVERSITY WETLAND CENTER

## MARSHES ONCE MORE

In 2003, many Ma'dan returned to their homes and broke open earthen dams, reflooding much of the marshlands. In some places, toxins in the soil and the loss of native plant species have prevented any kind of regeneration. But almost half of the original marshes now show signs of life: birds are returning, fish swim in the waters and reeds are growing in dense stands once again. Though the marshes of Mesopotamia may never reach their previous extent, they have been reborn.

© ERNEST BRAUN

## SAVE MONO LAKE

Mono Lake, California, is a bird's paradise: many nest there and millions more stop to fatten up on brine shrimp and alkali flies for their long migrations. But this oasis in arid eastern California almost disappeared. In the 1940s, Los Angeles filled its reservoirs by diverting water from the lake. The lake level dropped dramatically, jagged limestone towers were exposed and the complex food chain nearly collapsed. Since the 1980s, California has limited water taken from the lake and water levels have risen, bringing back bird habitat.


## A DYING DELTA

The Mississippi River Delta is one of the most heavily engineered wetlands in the world—and it's shrinking. Land on the coast naturally sinks and erodes. Left alone, the Mississippi River would deposit sediments and create new land fast enough to make up for the loss. But dams and levees prevent sediments from reaching the delta. The solution involves investment in large-scale projects designed to encourage land formation and clean up pollutants carried from farms along the river.

INTERNETWORK MEDIA/AGE FOTOSTOCK


## MANMADE LAND

Small barrier islands in the Gulf of Mexico slow storms as they approach the coastline, but most of these speed bumps have eroded away. Partly as a result, storms like Hurricane Katrina cause severe damage to cities and towns as well as natural ecosystems in the Mississippi Delta. Projects to rebuild entire islands in the gulf are underway: Wine Island was ringed by stones (top) and then filled with sediments. When fully restored (bottom) such islands can help reduce the risk of flooding in the delta.


USACE NEW ORLEANS DISTRICT

# epilogue

## What Can We Do?

Clean, plentiful water is not always available where and when it's needed. Indeed, water shortages and pollution threaten individuals, communities and countries around the globe.

But many water problems also have solutions. From households to huge cities, elected officials to entrepreneurs, everyone has a role to play in protecting Earth's water.


The U.S. Botanic Garden thanks the American Museum of Natural History for its loan of this exhibit for display in **One Planet—Ours.**

## Exhibition Interpretive Design

**Water: H2O = Life** has been designed by the Museum's Department of Exhibition, under the direction of David Harvey, Vice President for Exhibition.

## Web Site

The **Water: H2O = Life** web site was produced by Kathryn McGinley and developed by Michael Sullivan of the Museum's Department of Digital Media. Graphic design by Wichar Jiempreecha. Send comments to webmaster@amnh.org.

## Images