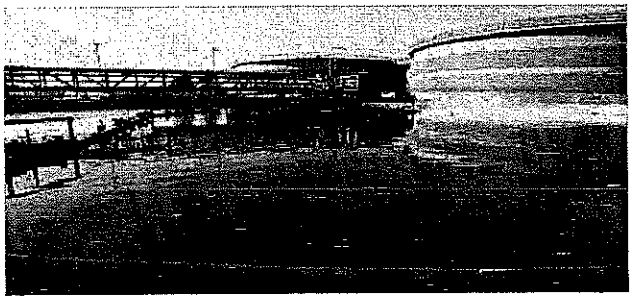
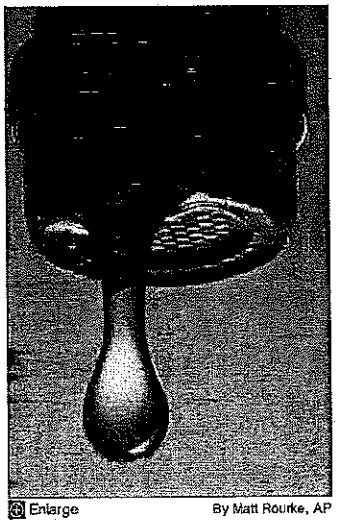


At the Orange County Sanitation District, a settling basin is used to filter water as part of the advanced secondary treatment, before the water is diverted into the ocean, in Fountain Valley, Calif. Pharmaceuticals in waterways are damaging wildlife across the nation and around the globe, research shows.

By Rio Francis, AP

AP: Drugs found in drinking water



Enlarge By Matt Rourke, AP

The federal government doesn't require any testing and hasn't set safety limits for drugs in water. Of the 62 major water providers contacted, the drinking water for only 28 was tested. Of the 28 major metropolitan areas where tests were performed on drinking water supplies, only Albuquerque; Austin, Texas; and Virginia Beach; said tests were negative.

By Jeff Donn, Martha Mendoza and Justin Pritchard, Associated Press

A vast array of pharmaceuticals — including antibiotics, anti-convulsants, mood stabilizers and sex hormones — have been found in the drinking water supplies of at least 41 million Americans, an Associated Press investigation shows.

To be sure, the concentrations of these pharmaceuticals are tiny, measured in quantities of parts per billion or trillion, far below the levels of a medical dose. Also, utilities insist their water is safe.

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But the presence of so many prescription drugs — and over-the-counter medicines like acetaminophen and ibuprofen — in so much of our drinking water is heightening worries among scientists of long-term consequences to human health.

In the course of a five-month inquiry, the AP discovered that drugs have been detected in the drinking water supplies of 24 major metropolitan areas — from Southern California to Northern New Jersey, from Detroit to Louisville

Water providers rarely disclose results of pharmaceutical screenings, unless pressed, the AP found. For example, the head of a group representing major California suppliers said the public "doesn't know how to interpret the information" and might be unduly alarmed.

How do the drugs get into the water?

People take pills. Their bodies absorb some of the medication, but the rest of it passes through and is flushed down the toilet. The wastewater is treated before it is discharged into reservoirs, rivers or lakes. Then, some of the water is cleansed again at drinking water treatment plants and piped to consumers. But most treatments do not remove all drug residue.

And while researchers do not yet understand the exact risks from decades of persistent exposure to random combinations of low levels of pharmaceuticals, recent studies — which have gone virtually unnoticed by the general public — have found alarming effects on human cells and wildlife.

"We recognize it is a growing concern and we're taking it very seriously," said Benjamin H. Grumbles, assistant administrator for water at the U.S. Environmental Protection Agency.

Members of the AP National Investigative Team reviewed hundreds of scientific reports, analyzed federal drinking water databases, visited environmental study sites and treatment plants and interviewed more than 230 officials, academics and scientists. They also surveyed the nation's 50 largest cities and a dozen other major water providers, as well as smaller community water providers in all 50 states.

Here are some of the key test results obtained by the AP:

TAP WATER TESTING

Here's the list of metropolitan areas, with the number of pharmaceuticals detected and some examples of specific drugs that were found, or where tests were negative, not conducted or awaiting results:

Albuquerque, N.M.: tests negative

Arlington, Texas: 1 (unspecified pharmaceutical)

Atlanta: 3 (acetaminophen, caffeine and cotinine)

Austin, Texas: tests negative

Baltimore: no testing

Birmingham, Ala.: no testing

Boston: no testing

Charlotte, N.C.: no testing

Chicago: no testing

Cincinnati: 1 (caffeine)

Cleveland: no testing

Colorado Springs, Colo.: no testing

Columbus, Ohio: 5 (azithromycin, roxithromycin, erosin, virginiamycin and

caffeine)

Concord, Calif.: 2 (meprobamate and sulfamethoxazole)

Dallas: results pending

Denver: (unspecified antibiotics)

Detroit: (unspecified drugs)

El Paso, Texas: no testing

Fairfax, Va.: no testing

Fort Worth, Texas: no testing

Fresno, Calif.: no testing

Honolulu: no testing

Houston: no testing

Indianapolis: 1 (caffeine)

Jacksonville, Fla.: no testing

Kansas City, Mo.: no testing

Las Vegas: 3 (carbamazepine, meprobamate and phenytoin)

Long Beach, Calif.: 2 (meprobamate and phenytoin)

Los Angeles: 2 (meprobamate and phenytoin)

Louisville, Ky.: 3 (caffeine, carbamazepine and phenytoin)

Memphis, Tenn.: no testing

Mesa, Ariz.: no testing

Miami: no testing

Milwaukee: 1 (cotinine)

Minneapolis: 1 (caffeine)

Nashville, Tenn.: no testing

New Orleans: 3 (clofibric acid, estrone and naproxen)

New York City: no testing

Northern New Jersey: 7 (caffeine, carbamazepine, codeine, cotinine, dehydronifedipine, diphenhydramine and sulfathiazole)

Oakland, Calif.: no testing

Oklahoma City: no testing

Omaha, Neb.: no testing

Orlando, Fla.: no testing

Philadelphia: 56 (including amoxicillin, azithromycin, carbamazepine, diclofenac, prednisone and tetracycline)

Phoenix: no testing

Portland, Ore.: 4 (acetaminophen, caffeine, ibuprofen and sulfamethoxazole)

Prince George's and Montgomery counties, Md.: no testing

Riverside County, Calif.: 2 (meprobamate and phenytoin)

Sacramento, Calif.: no testing

San Antonio: no testing

San Diego: 3 (ibuprofen, meprobamate and phenytoin)

San Francisco: 1 (estradiol)

San Jose, Calif.: no testing

Santa Clara, Calif.: no testing

Seattle: no testing

Southern California: 2 (meprobamate and phenytoin)

Suffolk County, N.Y.: no testing

Tucson, Ariz.: 3 (carbamazepine, dehydronifedipine and sulfamethoxazole)

Tulsa, Okla.: no testing

Virginia Beach, Va.: tests negative

Washington, D.C.: 6 (carbamazepine, caffeine, ibuprofen, monensin, naproxen and sulfamethoxazole)

Wichita, Kan.: no testing.

About the study:

At least one pharmaceutical was detected in tests of treated drinking water supplies for 24 major metropolitan areas, according to an Associated Press survey of 62 major water providers and data obtained from independent researchers.

• Officials in Philadelphia said testing there discovered 56 pharmaceuticals or byproducts in treated drinking water, including medicines for pain, infection, high cholesterol, asthma, epilepsy, mental illness and heart problems. Sixty-three pharmaceuticals or byproducts were found in the city's watersheds.

• Anti-epileptic and anti-anxiety medications were detected in a portion of the treated drinking water for 18.5 million people in Southern California.

• Researchers at the U.S. Geological Survey analyzed a Passaic Valley Water Commission drinking water treatment plant, which serves 850,000 people in Northern New Jersey, and found a metabolized angina medicine and the mood-stabilizing carbamazepine in drinking water.

• A sex hormone was detected in San Francisco's drinking water.

• The drinking water for Washington, D.C., and surrounding areas tested positive for six pharmaceuticals.

• Three medications, including an antibiotic, were found in drinking water supplied to Tucson.

The situation is undoubtedly worse than suggested by the positive test results in the major population centers documented by the AP.

The federal government doesn't require any testing and hasn't set safety limits for drugs in water. Of the 62 major water providers contacted, the drinking water for only 28 was tested. Among the 34 that haven't: Houston, Chicago, Miami, Baltimore, Phoenix, Boston and New York City's Department of Environmental Protection, which delivers water to 9 million people.

Some providers screen only for one or two pharmaceuticals, leaving open the possibility that others are present.

The AP's investigation also indicates that watersheds, the natural sources of most of the nation's water supply, also are contaminated. Tests were conducted in the watersheds of 35 of the 62 major providers surveyed by the AP, and pharmaceuticals were detected in 28.

Yet officials in six of those 28 metropolitan areas said they did not go on to test their drinking water — Fairfax, Va.; Montgomery County in Maryland; Omaha; Oklahoma City; Santa Clara, Calif., and New York City.

The New York state health department and the USGS tested the source of the city's water, upstate. They found trace concentrations of heart medicine, infection fighters, estrogen, anti-convulsants, a mood stabilizer and a tranquilizer.

City water officials declined repeated requests for an interview. In a statement, they insisted that "New York City's drinking water continues to meet all federal and state regulations regarding drinking water quality in the watershed and the distribution system" — regulations that do not address trace pharmaceuticals.

In several cases, officials at municipal or regional water providers told the AP that pharmaceuticals had not been detected, but the AP obtained the results of tests conducted by independent researchers that showed otherwise. For example, water department officials in New Orleans said their water had not been tested for pharmaceuticals, but a Tulane University researcher and his students have published a study that found the pain reliever naproxen, the sex hormone estrone and the anti-cholesterol drug byproduct clofibric acid in treated drinking water.

Of the 28 major metropolitan areas where tests were performed on drinking water supplies, only Albuquerque; Austin, Texas; and Virginia Beach; said tests were negative. The drinking water in Dallas has been tested, but officials are awaiting results. Arlington, Texas, acknowledged that traces of a pharmaceutical were detected in its drinking water but cited post-9/11 security concerns in refusing to identify the drug.

The AP also contacted 52 small water providers — one in each state, and two each in Missouri and Texas — that serve communities with populations around 25,000. All but one said their drinking water had not been screened for pharmaceuticals; officials in Emporia, Kan., refused to answer AP's questions, also citing post-9/11 issues.

Rural consumers who draw water from their own wells aren't in the clear either, experts say.

The Stroud Water Research Center, in Avondale, Pa., has measured water samples from New York City's upstate watershed for caffeine, a common contaminant that scientists often look for as a possible signal for the presence of other pharmaceuticals. Though more caffeine was detected at suburban sites, researcher Anthony Aufdenkampe was struck by the relatively high levels even in less populated areas.

Only 28 tested drinking water. Three of those said results were negative; Dallas says tests were conducted but results are not yet available. Thirty-four locations said no testing was conducted.

Test protocols varied widely. Some researchers looked only for one pharmaceutical or two; others looked for many.

Some water systems said tests had been negative, but the AP found independent research showing otherwise. Both prescription and non-prescription drugs were detected.

Because coffee and tobacco are so widely used, researchers say their byproducts are good indicators of the presence of pharmaceuticals. Thus, they routinely test for, and often find, both caffeine and nicotine's metabolite cotinine more frequently than other drugs.

Source: The Associated Press

Enlarge By Jae C. Hong, AP

Duane Moser, an assistant research professor with Desert Research Institute, collects water samples from the Las Vegas Wash in Henderson, Nev.

ILL EFFECTS?

Troubled by drugs discovered in European waters, poisons expert and biologist Francesco Pomati set up an experiment: He exposed developing human kidney cells to a mixture of 13 drugs at levels mimicking those found in Italian rivers.

There were drugs to fight high cholesterol and blood pressure, seizures and depression, pain and infection, and cancer, all in tiny amounts.

The result: The pharmaceutical blend slowed cell growth by up to a third suggesting that scant amounts may exert powerful effects, said Pomati, who works at the University of New South Wales in Sydney, Australia.

Taken alone, this was a modest study. But in fact Pomati's work is part of a body of emerging scientific studies that indicate that over time, humans could be harmed by ingesting drinking water contaminated with tiny amounts of pharmaceuticals.

In another recently published study, Pomati discovered that some of those pharmaceuticals could amplify or reverse the effects of some others.

And Pomati's work indicates some drugs cause cellular effects at scant concentrations that strangely cannot be seen at higher levels.

Such findings are preliminary; they alone cannot demonstrate the same effects within the human body. But they provide scientific hints, just like cellular experiments that routinely guide discovery of new drugs.

They also heighten worry about the possible effects on especially vulnerable groups, like the very young, old or sick. "My wife is pregnant, and I don't let my wife drink the water ...," said Pomati.

Elsewhere in the world, other researchers are finding results similar to Pomati's.

In research awaiting publication, human breast cancer cells grew twice as fast when exposed to estrogens taken from catfish caught near untreated sewage overflows in Pennsylvania, compared with other fish.

The University of Pittsburgh researchers didn't calculate how much effect came from pharmaceuticals instead of natural hormones, but their earlier work points to birth-control pills and hormone treatments as important contributors, said lead researcher Conrad Volz.

"There is the potential for an increased risk for those people who are prone to estrogenic cancer," said Volz, who studies environmental hazards at the university's Cancer Institute.

He suspects it escapes from failed septic tanks, maybe with other drugs. "Septic systems are essentially small treatment plants that are essentially unmanaged and therefore tend to fail," Aufdenkampe said.

Even users of bottled water and home filtration systems don't necessarily avoid exposure. Bottlers, some of which simply repackage tap water, do not typically treat or test for pharmaceuticals, according to the industry's main trade group. The same goes for the makers of home filtration systems.

Contamination is not confined to the United States. More than 100 different pharmaceuticals have been detected in lakes, rivers, reservoirs and streams throughout the world. Studies have detected pharmaceuticals in waters throughout Asia, Australia, Canada and Europe — even in Swiss lakes and the North Sea.

For example, in Canada, a study of 20 Ontario drinking water treatment plants by a national research institute found nine different drugs in water samples. Japanese health officials in December called for human health impact studies after detecting prescription drugs in drinking water at seven different sites.

In the United States, the problem isn't confined to surface waters. Pharmaceuticals also permeate aquifers deep underground, source of 40% of the nation's water supply. Federal scientists who drew water in 24 states from aquifers near contaminant sources such as landfills and animal feed lots found minuscule levels of hormones, antibiotics and other drugs.

Perhaps it's because Americans have been taking drugs — and flushing them unmetabolized or unused — in growing amounts. Over the past five years, the number of U.S. prescriptions rose 12% to a record 3.7 billion, while non-prescription drug purchases held steady around 3.3 billion, according to IMS Health and The Nielsen Co.

"People think that if they take a medication, their body absorbs it and it disappears, but of course that's not the case," said EPA scientist Christian Daughton, one of the first to draw attention to the issue of pharmaceuticals in water in the United States.

Some drugs, including widely used cholesterol fighters, tranquilizers and anti-epileptic medications, resist modern drinking water and wastewater treatment processes. Plus, the EPA says there are no sewage treatment systems specifically engineered to remove pharmaceuticals.

One technology, reverse osmosis, removes virtually all pharmaceutical contaminants but is very expensive for large-scale use and leaves several gallons of polluted water for every one that is made drinkable.

Another issue: There's evidence that adding chlorine, a common process in conventional drinking water treatment plants, makes some pharmaceuticals more toxic.

Human waste isn't the only source of contamination. Cattle, for example, are given ear implants that provide a slow release of trenbolone, an anabolic steroid used by some bodybuilders, which causes cattle to bulk up. But not all the trenbolone circulating in a steer is metabolized. A German study showed 10% of the steroid passed right through the animals.

Water sampled downstream of a Nebraska feedlot had steroid levels four times as high as the water taken upstream. Male fathead minnows living in that downstream area had low testosterone levels and small heads.

Other veterinary drugs also play a role. Pets are now treated for arthritis, cancer, heart disease, diabetes, allergies, dementia, and even obesity — sometimes with the same drugs as humans. The inflation-adjusted value of veterinary drugs rose by 8%, to $5.2 billion, over the past five years, according to an analysis of data from the Animal Health Institute.

Ask the pharmaceutical industry whether the contamination of water supplies is a problem, and officials will tell you no. "Based on what we now know, I would say we find there's little or no risk from pharmaceuticals in the environment to human health," said microbiologist Thomas White, a consultant for the Pharmaceutical Research and Manufacturers of America.

But at a conference last summer, Mary Buzby — director of environmental technology for drug maker Merck & Co. Inc. — said: "There's no doubt about it, pharmaceuticals are being detected in the environment and there is genuine concern that these compounds, in the small concentrations that they're at, could be causing impacts to human health or to aquatic organisms."

Recent laboratory research has found that small amounts of medication have affected human embryonic kidney cells, human blood cells and human breast cancer cells. The cancer cells proliferated too quickly; the kidney cells grew too slowly; and the blood cells showed biological activity associated with inflammation.

He said people who regularly drink water containing low levels of hormones may be at higher risk, since they would presumably consume more of these drugs than those who only occasionally eat such fish.

Scientists at the Helmholtz research center in Leipzig, Germany, linked low levels of the pain reliever diclofenac to an inflammatory-like response in human blood cells, according to biologist Kristin Schirmer. Inflammation at the wrong time and place plays a role in conditions ranging from infections and arthritis to heart disease.

Sandra Steingraber, a biologist at New York's Ithaca College, adds that many efforts to determine how trace drugs affect humans don't fully consider the whole range of pharmaceuticals in the environment and whether someone has been exposed at more susceptible times, like during childhood or old age.

"The timing makes the poison as much as the dose," she said. "And the dose itself is not the dose from just any one thing it's from this whole kaleidoscope of chemicals."

Taking notice of accumulating evidence, the drug industry has backed studies of its own in recent years that have found very slight, if any, risk to humans.

But these studies haven't used water samples analyzed for drugs. Instead, the studies estimate danger from what's known about how much of a drug is sold and how toxic it is to animals. Then, safety margins are added for unknowns, such as possible effects of decades of exposure.

Those margins are just educated guesses. Also, the studies usually ignore what might happen to people exposed to the complex combinations of medicines that are often found in drinking water.

Then, there are the byproducts of the drugs. When medications are digested and processed through water treatment plants, they may take a new metabolic form.

"They miss some of the big issues. Our research shows mixtures are so prevalent," said Dana Kolpin, a U.S. Geological Survey water expert who launched a plethora of research in 2002 after finding pharmaceuticals in most samples taken from 139 streams in 30 states. "If there are any cumulative or additive issues, you can't just dismiss things so quickly."

Even if Kolpin is right, the industry may be focusing on the wrong pharmaceuticals, said chemist James Shine at the Harvard School of Public Health, who oversaw what's probably the broadest risk review yet, a yet-to-be-published study covering scores of the most common drugs sold in the United States.

As suspected, some chemotherapy drugs turn up high on that list. But blood-pressure diuretics, though rarely considered, appear to pose more risk than many drugs more often evaluated.

Even when researchers downplay risk, that may not be the final word.

People "are going to be concerned about being medicated by mandate when you turn on the tap," said Dr. Stevan Gressitt, a psychiatrist who's led a push for a program in Maine that allows consumers to turn in unused pharmaceuticals for secure disposal or destruction. "And that's going to be seen if the level is (only) one molecule in 100 taps."

-- *The Associated Press*

Also, pharmaceuticals in waterways are damaging wildlife across the nation and around the globe, research shows. Notably, male fish are being feminized, creating egg yolk proteins, a process usually restricted to females. Pharmaceuticals also are affecting sentinel species at the foundation of the pyramid of life — such as earth worms in the wild and zooplankton in the laboratory, studies show.

Some scientists stress that the research is extremely limited, and there are too many unknowns. They say, though, that the documented health problems in wildlife are disconcerting.

"It brings a question to people's minds that if the fish were affected ... might there be a potential problem for humans?" EPA research biologist Vickie Wilson told the AP. "It could be that the fish are just exquisitely sensitive because of their physiology or something. We haven't gotten far enough along."

With limited research funds, said Shane Snyder, research and development project manager at the Southern Nevada Water Authority, a greater emphasis should be put on studying the effects of drugs in water.

"I think it's a shame that so much money is going into monitoring to figure out if these things are out there, and so little is being spent on human health," said Snyder. "They need to just accept that these things are everywhere — every chemical and pharmaceutical could be there. It's time for the EPA to step up to the plate and make a statement about the need to study effects, both human and environmental."

To the degree that the EPA is focused on the issue, it appears to be looking at detection. Grumbles acknowledged that just late last year the agency developed three new methods to "detect and quantify pharmaceuticals" in wastewater. "We realize that we have a limited amount of data on the concentrations," he said. "We're going to be able to learn a lot more."

While Grumbles said the EPA had analyzed 287 pharmaceuticals for possible inclusion on a draft list of candidates for regulation under the Safe Drinking Water Act, he said only one, nitroglycerin, was on the list. Nitroglycerin can be used as a drug for heart problems, but the key reason it's being considered is its widespread use in making explosives.

So much is unknown. Many independent scientists are skeptical that trace concentrations will ultimately prove to be harmful to humans. Confidence about human safety is based largely on studies that poison lab animals with much higher amounts.

There's growing concern in the scientific community, meanwhile, that certain drugs — or combinations of drugs — may harm humans over decades because water, unlike most specific foods, is consumed in sizable amounts every day.

Our bodies may shrug off a relatively big one-time dose, yet suffer from a smaller amount delivered continuously over a half century, perhaps subtly stirring allergies or nerve damage. Pregnant women, the elderly and the very ill might be more sensitive.

Many concerns about chronic low-level exposure focus on certain drug classes: chemotherapy that can act as a powerful poison; hormones that can hamper reproduction or development; medicines for depression and epilepsy that can damage the brain or change behavior; antibiotics that can allow human germs to mutate into more dangerous forms; pain relievers and blood-pressure diuretics.

For several decades, federal environmental officials and non-profit watchdog environmental groups have focused on regulated contaminants — pesticides, lead, PCBs — which are present in higher concentrations and clearly pose a health risk.

However, some experts say medications may pose a unique danger because, unlike most pollutants, they were crafted to act on the human body.

"These are chemicals that are designed to have very specific effects at very low concentrations. That's what pharmaceuticals do. So when they get out to the environment, it should not be a shock to people that they have effects," says zoologist John Sumpter at Brunel University in London, who has studied trace hormones, heart medicine and other drugs.

And while drugs are tested to be safe for humans, the timeframe is usually over a matter of months, not a lifetime. Pharmaceuticals also can produce side effects and interact with other drugs at normal medical doses. That's why — aside from therapeutic doses of fluoride injected into potable water supplies — pharmaceuticals are prescribed to people who need them, not delivered to everyone in their drinking water.

"We know we are being exposed to other people's drugs through our drinking water, and that can't be good," says Dr. David Carpenter, who directs the Institute for Health and the Environment of the State University of New York at Albany.

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AMERICA

Trump Aims To 'Eliminate' Clean Water Rule

February 28, 2017 · 3:14 PM ET

MERRIT KENNEDY | SUSAN PHILLIPS

Massey Run, an intermittent stream that runs into Crum Creek in Pennsylvania's Chester County, is impacted by the Waters of the United States rule.

Kimberly Paynter/WHYY

Updated 5:35 p.m. ET

The Trump administration is moving to roll back an environmental rule intended to define which small bodies of water are subject to federal authority under the Clean Water Act.

President Trump signed documents Tuesday directing the Environmental Protection Agency and the U.S. Army Corps of Engineers to review the Obama administration's "Waters of the United States" rule. In doing so, Trump said he is "paving the way for the elimination" of the rule.

He asked for the reviewers to assess its consistency with "promoting economic growth" and "minimizing regulatory uncertainty," among other factors.

Supporters say the regulation is needed to ensure safe drinking water. But a long list of opponents say it goes too far and poses a burden on them. The rule is currently on hold after a stay by the 6th U.S. Circuit Court of Appeals.

"It was a massive power grab," Trump said as he prepared to sign the documents, surrounded by a group of farmers, homebuilders and county commissioners. "Regulations and permits started treating our wonderful small farmers and small businesses as if they were a major industrial polluter. They treated them horribly."

But as NPR's Greg Allen has reported, "overturning the rule isn't something that can be done through executive order. The EPA would have to restart the lengthy rule-making process, according to Jon Devine, an attorney with the Natural Resources Defense Council."

Trump's executive order has been sharply criticized by environmental groups. Earthjustice accused the president of "demonstrating that he puts the interests of corporate polluters above the public's health."

When the Clean Water Act passed in 1972, it defined waters that would need protection from pollution as "navigable." For most of us, that means big enough to float a boat. Over the years, though, it became clear that smaller streams and wetlands needed protection as well, especially those that feed into rivers and lakes that provide drinking water. But Congress and successive administrations tried, and failed, to clarify exactly which waters were subject to the act. The Army Corps of Engineers interpreted the act differently in different regions of the U.S., and courts only added to the confusion.

The Obama administration tried once and for all to settle the question with the Waters of the United States rule in 2015. At the time, it was hailed by the Obama administration as protecting the water supply for about 117 million Americans.

But it faced heavy criticism and lobbying against the rule from farmers, the U.S. Chamber of Commerce, real estate developers and golf course owners, among others.

In Tuesday's executive order, Trump said that in any future proposed rule, the EPA and the U.S. Army Corps of Engineers should consider Justice Antonin Scalia's opinion in a 2006 Supreme Court ruling, which focused on the scope of the Clean Water Act.

In that case, Scalia stated that the "waters of the United States" are limited to "only relatively permanent, standing or flowing bodies of water." He added: "The phrase does not include channels through which water flows intermittently or ephemerally, or channels that periodically provide drainage for rainfall."

After the 2015 rule, Owen McDonough of the National Association of Homebuilders said a developer who buys a rural piece of land "is all of a sudden faced with jurisdiction waters, and then he has to secure federal permits, and offset his impacts." He said builders must hire expensive environmental consultants to get those permits.

Last August, then-candidate Trump echoed that criticism when he addressed the homebuilders association. It's worth noting that Trump has a stake in the rule's fate. As Greg has reported, the Trump Organization has about a dozen golf courses across the U.S.

And the president's new EPA chief, Scott Pruitt, sued the agency over the water rule when he was Oklahoma's attorney general.

The American Farm Bureau Federation also launched a campaign called "Ditch the Rule." In an ad featuring a farmer's wife running barefoot in a field, it asserted that the Waters of the U.S. rule would force farmers to get a permit for every ditch or puddle on their land. The bureau also says the rule goes overboard by including so-called prairie potholes, which don't have water in them year-round.

"The [Obama] administration really belittled a lot of farmers' concerns," says the Farm Bureau's Don Parrish. He says growers who fail to get a needed permit could face heavy fines or even jail time.

But Ellen Gilinsky, a former EPA administrator who advised on the Waters of the U.S. Rule, says many such fears are overblown. She says the rule actually reduced the number of ditches that would require permits and that both farmers and ranchers have numerous exemptions.

"I really think there's a lot of blood shed over this rule that didn't need to be," Gilinsky says. "I think there's an opportunity to take another look at it and bring everyone to the table and get a rule everyone can feel good about."

Supporters of the Waters of the United States rule say states simply don't have the resources to ensure healthy streams and clean drinking water on their own. Gilinsky says she hopes the Trump administration can finally get all sides to agree on which waters the federal government should protect.

Susan Phillips is a reporter with StateImpact Pennsylvania.

Correction

March 1, 2017

An earlier version of this story said Massey Run stream is located in Pennsylvania's Montgomery County. In fact, it is in Chester County.

clean power plan carbon pollution environmental protection agency

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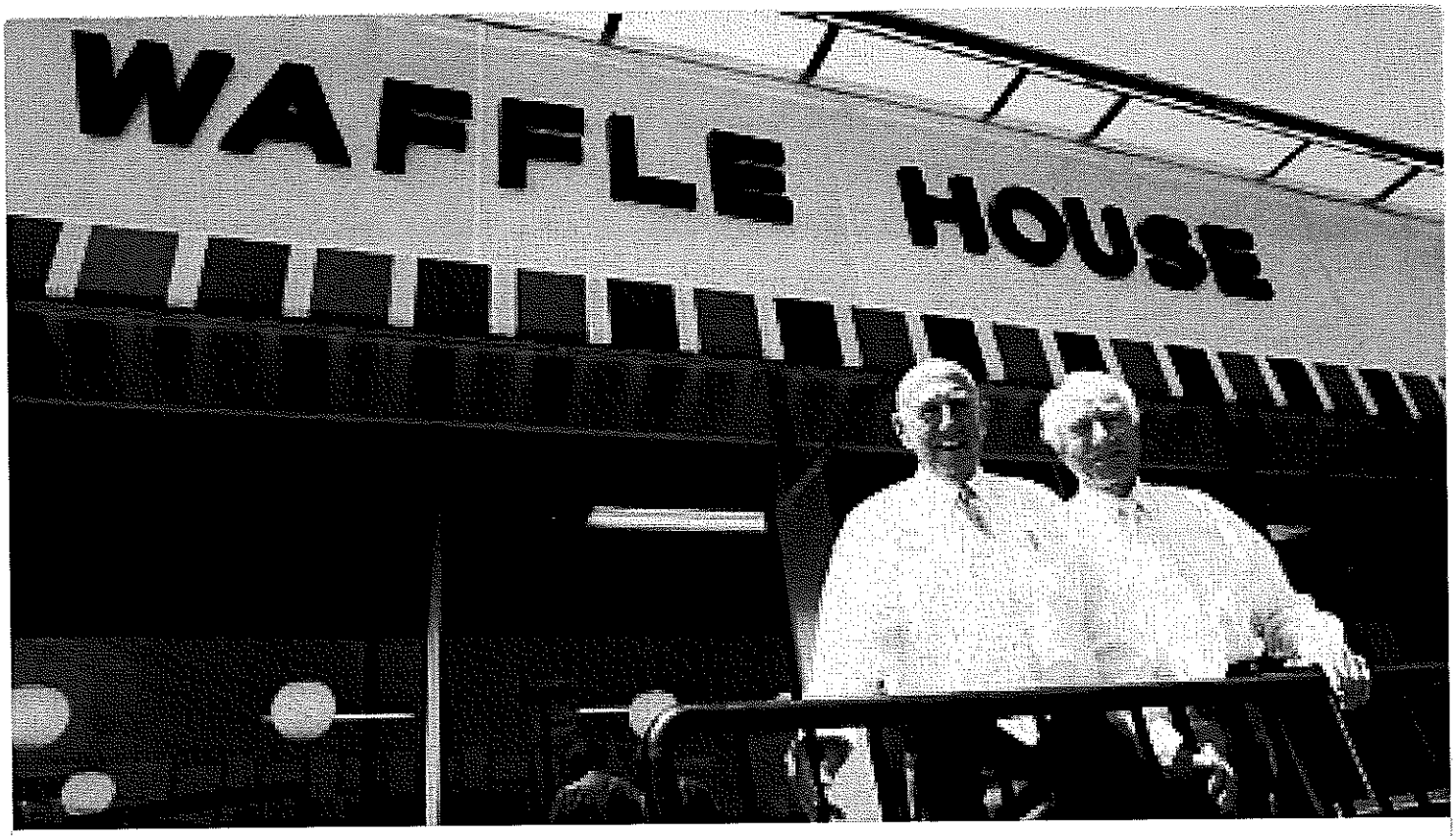

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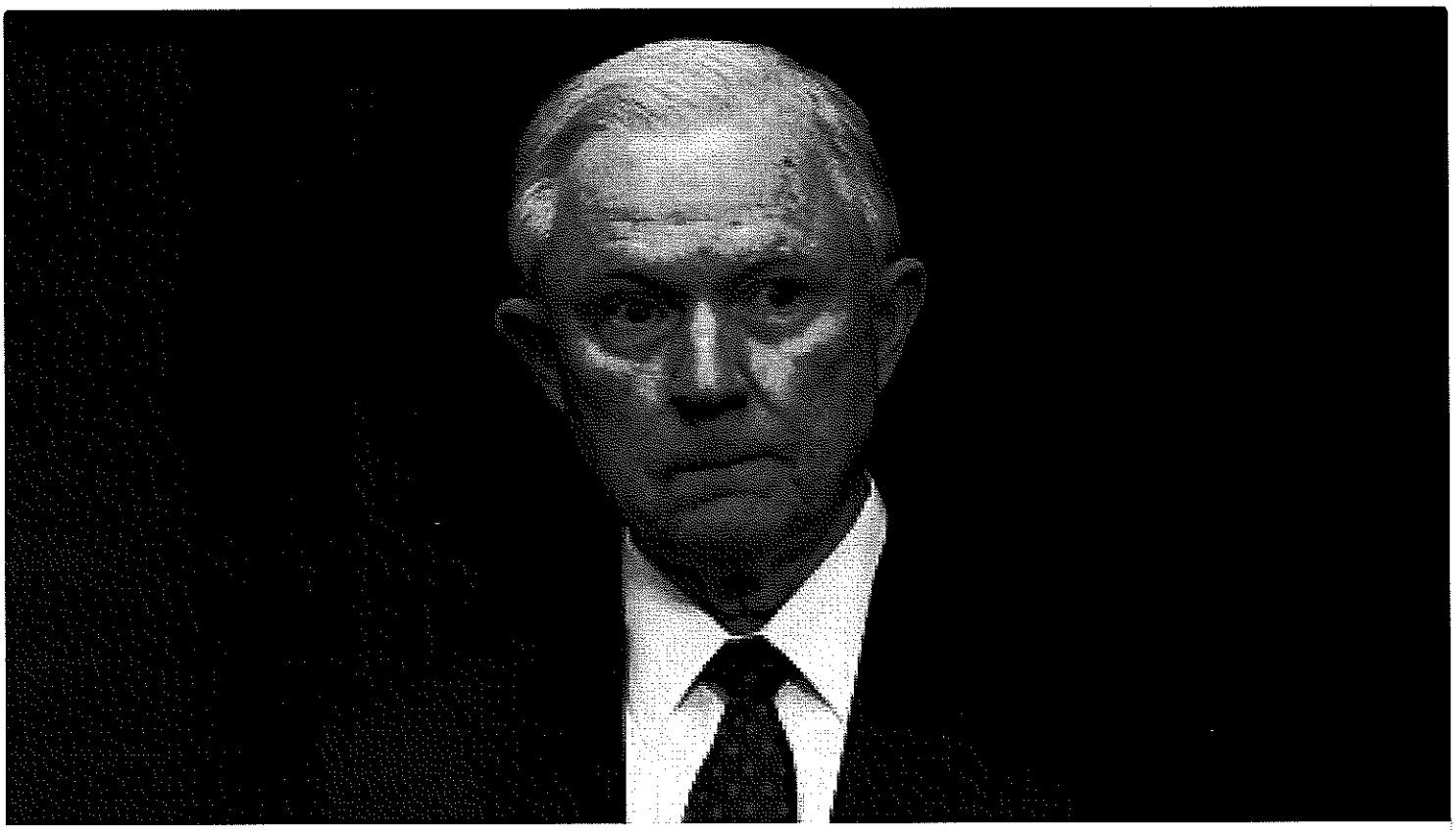

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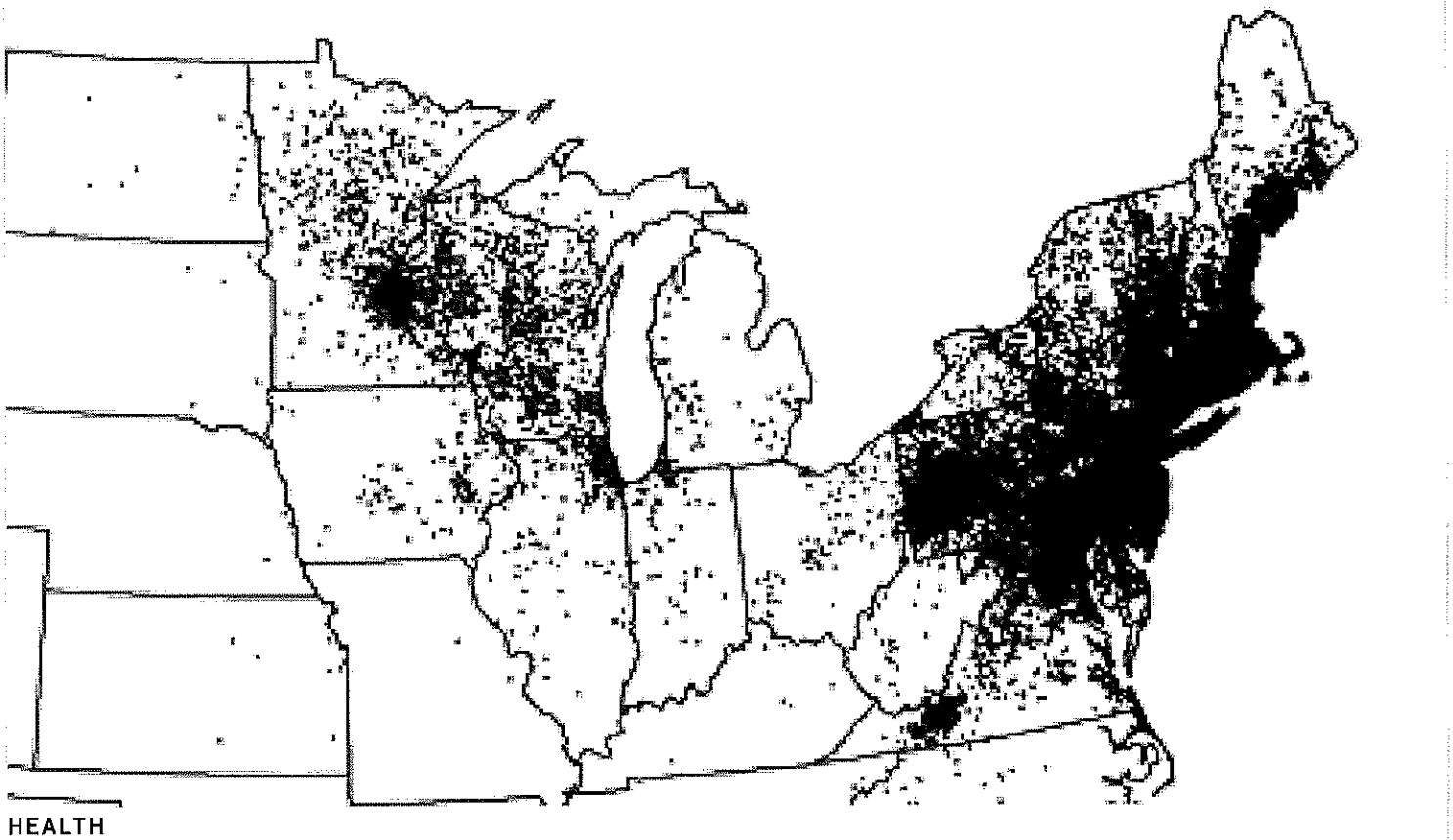

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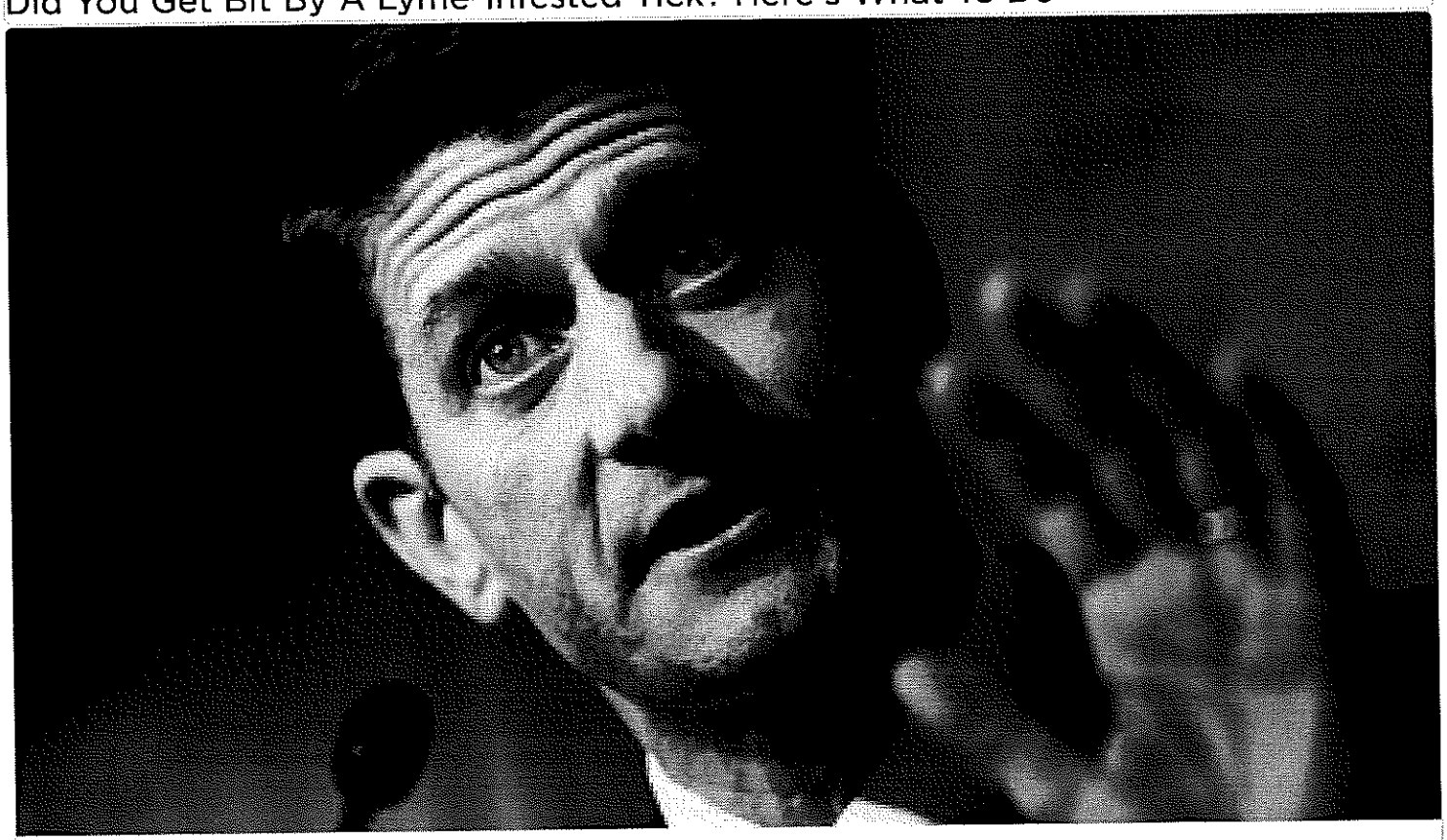

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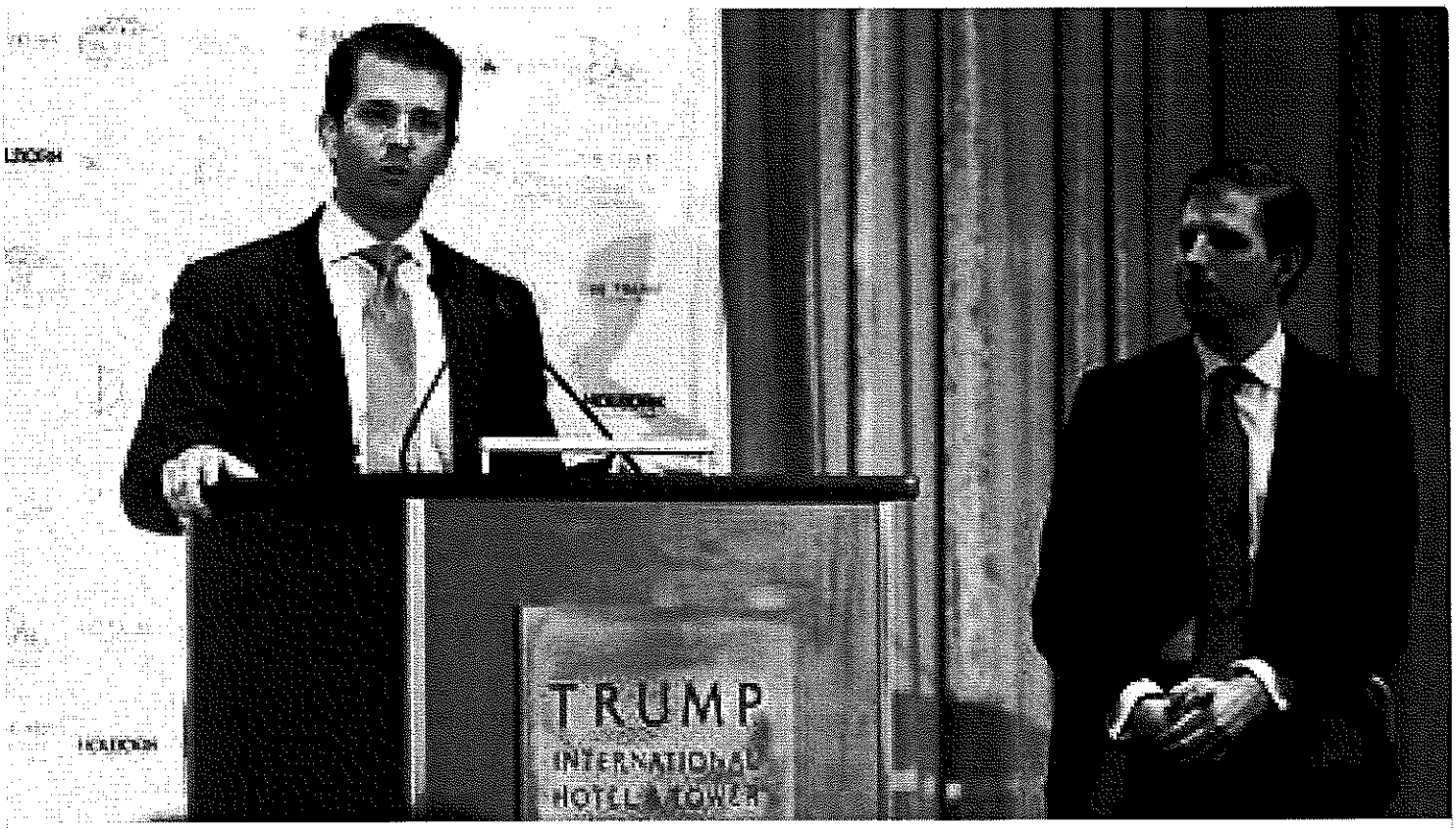

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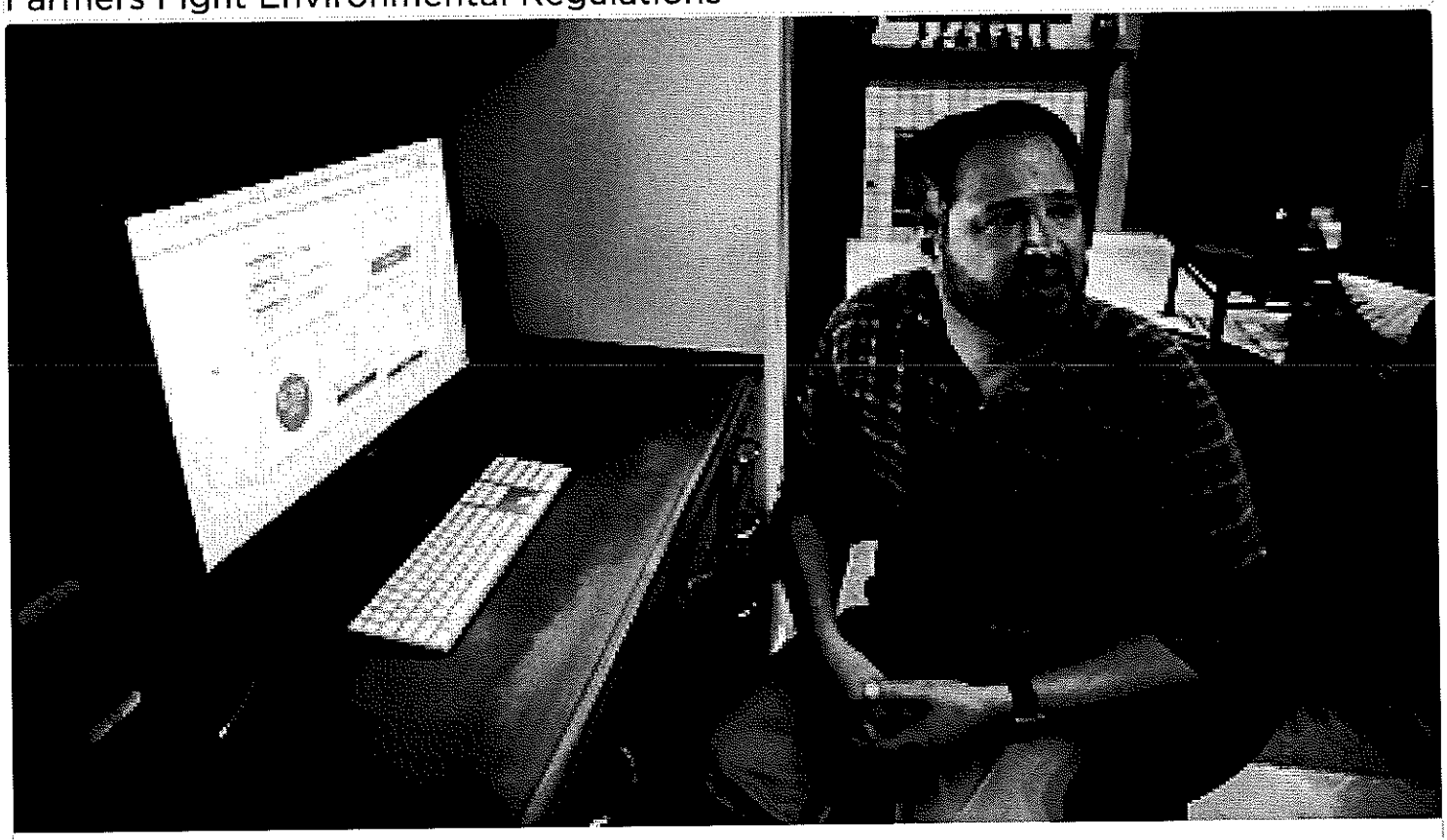

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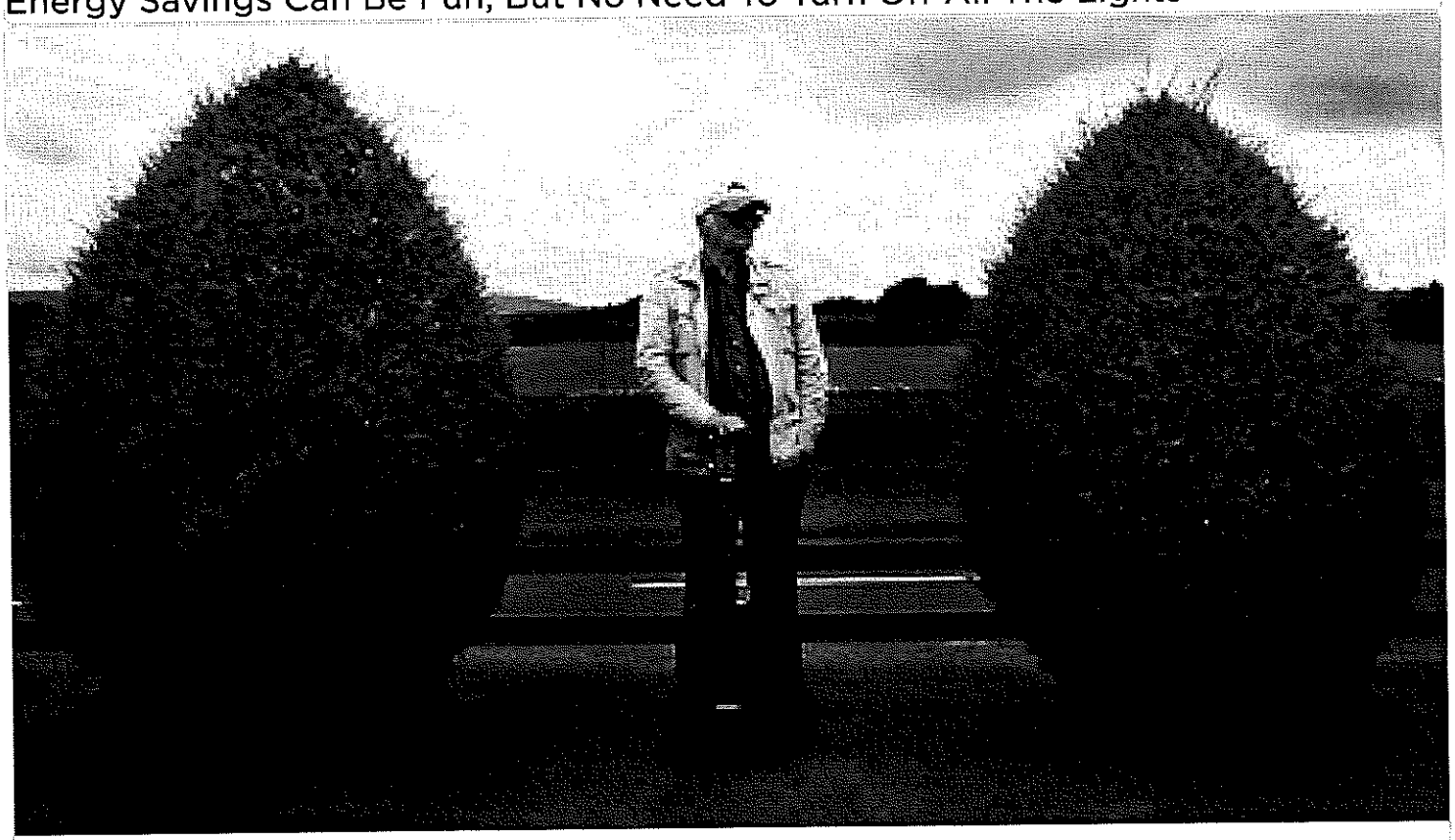

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8.3 J. W. MAURITS LA RIVIÈRE

Threats to the World's Water

All the world's creatures (other than those that live in the oceans) are dependent on an adequate supply of uncontaminated freshwater. Unfortunately, this precious resource is in increasingly short supply in many parts of the world. This is the result of inappropriate and wasteful human agricultural, industrial, and domestic water usage that has polluted a large fraction of the earth's lakes, rivers, and aquifers, while placing increasing demand on those that remain relatively pure.

J. W. Maurits la Rivière is a distinguished environmental microbiologist and a former chair of the environmental engineering department at the International Institute for Hydraulic and Environmental Engineering in Delft, The Netherlands. An outspoken leader on water quality issues, he has also served as secretary general of the International Council of Scientific Unions and as president of that organization's Scientific Committee on Problems of the Environment.

In the following selection from "Threats to the World's Water," *Scientific American* (September 1989), la Rivière describes the various factors—including population growth, ignorance, poverty, and unsustainable development—that will result in severe water shortages if corrective action is not taken soon.

Key Concept: water shortage as a threat to the future of the human species

Water is the earth's most distinctive constituent. It set the stage for the evolution of life and is an essential ingredient of all life today; it may well be the most precious resource the earth provides to humankind. One might therefore suppose that human beings would be respectful of water, that they would seek to maintain its natural reservoirs and safeguard its purity. Yet people in countries throughout the world have been remarkably shortsighted and negligent in this respect. Indeed, the future of the human species and many others may be compromised unless there is significant improvement in the management of the earth's water resources.

All the fresh water in the world's lakes and creeks, streams and rivers represents less than .01 percent of the earth's total store of water. Fortunately,

this freshwater supply is continually replenished by the precipitation of water vapor from the atmosphere as rain or snow. Unfortunately, much of that precipitation is contaminated on the way down by gases and particles that human activity introduces into the atmosphere.

Fresh water runs off the land and on its way to the ocean becomes laden with particulate and dissolved matter—both natural detritus and the wastes of human society. When the population density in the catchment area is low, waste matter in the water can be degraded by microbes through a process known as natural self-purification. When the self-purifying capacity of the catchment area is exceeded, however, large quantities of these waste substances accumulate in the oceans, where they can harm aquatic life. The water itself evaporates and enters the atmosphere as pure water vapor. Much of it falls back into the ocean; what falls on land is the previous renewable resource on which terrestrial life depends.

The World Resources Institute estimates that 41,000 cubic kilometers of water per year return to the sea from the land, counterbalancing the atmospheric vapor transport from sea to land. Some 27,000 cubic kilometers, however, return to the sea as flood runoff, which cannot be tapped, and another 5,000 cubic kilometers flow into the sea in uninhabited areas. Of the 41,000 cubic kilometers that return to the sea, some amount is retained on land, where it is absorbed by the vegetation, but the precise amount is not known.

This cycle leaves about 9,000 cubic kilometers readily available for human exploitation worldwide. That is a plentiful supply of water, in principle enough to sustain 20 billion people. Yet because both the world's population and usable water are unevenly distributed, the local availability of water varies widely. When evaporation and precipitation balances are worked out for each country, water-poor and water-rich countries can be identified. Iceland, for example, has enough excess precipitation to provide 68,500 cubic meters of water per person per year. The inhabitants of Bahrain, on the other hand, have virtually no access to natural fresh water; they are dependent on the desalinization of seawater. In addition, withdrawal rates per person differ widely from country to country: the average U.S. resident consumes more than 70 times as much water every year as the average resident of Ghana does.

Although the uses to which water is put vary from country to country, agriculture is the main drain on the water supply. Averaged globally, 73 percent of water withdrawn from the earth goes for that purpose. Almost three million square kilometers of land have been irrigated—an area nearly the size of India—and more is being added at the rate of 8 percent a year.

Local water shortages can be solved in two ways. The supply can be increased, either by damming rivers or by consuming capital—by "mining" groundwater. Or known supplies can be conserved, as by increasing the efficiency of irrigation or by relying more on food imports.

In spite of such efforts, there is no doubt that water is becoming increasingly scarce as population, industry and agriculture all expand. Severe shortages occur as demand exceeds supply. Depletion of groundwater is common in, for example, India, China and U.S. In the Soviet Union the water level of both the Aral sea and Lake Baikal is dropping dramatically as a result of agricultural and industrial growth in those areas. Contentious competition for the water of such international rivers as the Nile, the Jordan, the Ganges and the Brahmaputra is a symptom of the increasing scarcity of water.

Another problem brought on by overirrigation is salinization. As water evaporates and is taken up by plants, salt is left behind in the soil. The rate of deposition exceeds the rate at which the salt can be removed by flowing water, and so a residue accumulates. Currently more than a million hectares every year are subject to salinization; in the U.S. alone more than 20 percent of the irrigated land is thus affected.

Human activity in a river basin can often aggravate flood hazards. Deforestation and excessive logging lead not only to increased soil erosion but also to increased runoff; in addition, navigation canals are sometimes dug, which may exacerbate flooding by increasing the amount of water that reaches the floodplain.

Finally, of course, any human activity that accentuates the greenhouse effect and ensuing climatic change must inevitably influence the global water cycle. A projected sea-level rise of between .5 and 1.5 meters in the next century, for instance, not only would pose a coastal flooding problem but also would lead to salinization of water resources, create new wetlands while destroying existing ones and increase the ratio of salt water to fresh water on the globe. Precipitation could rise by between 7 and 15 percent in the aggregate; the geographic variations are not predictable.

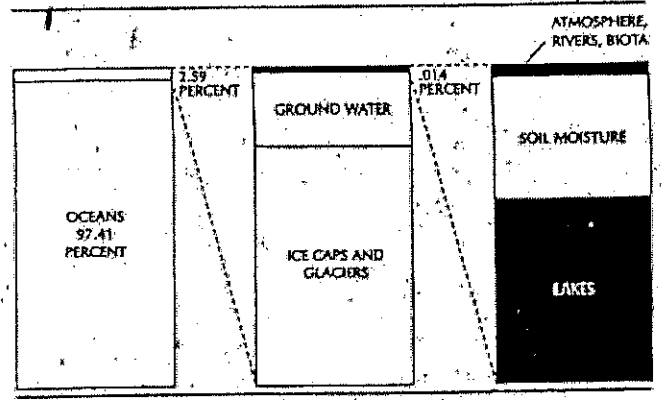
Assuring an adequate supply is not the only water problem facing many countries throughout the world: they need to worry about water quality. In its passage through the hydrological cycle, water is polluted by two kinds of waste. There is traditional organic waste: human and animal excreta and agricultural fibrous waste (the discarded parts—often more than half—of harvested plants). And there is waste generated by a wide range of industrial processes and by the disposal, after a brief or long lifetime, of industry's products.

Although organic waste is fully biodegradable, it nonetheless presents a significant problem—and in some places a massive one. Excessive biodegradation can cause oxygen depletion in lakes and rivers. Human excreta contain some of the most vicious contaminants known, including such pathogenic microorganisms as the waterborne agents of cholera, typhoid fever and dysentery.

Industrial waste can include heavy metals and considerable quantities of synthetic chemicals, such as pesticides. These materials are characterized by toxicity and persistence: they are not readily degraded under natural conditions or in conventional sewage-treatment plants. On the other hand, such industrial materials as concrete, paper, glass, iron and certain plastics are relatively innocuous, because they are inert, biodegradable or at least nontoxic.

Wastes can enter lakes and streams in discharges from such point sources as sewers or drainage pipes or from diffuse sources, as in the case of pesticides and fertilizers in runoff water. Wastes can also be carried to lakes and streams along indirect pathways—for example, when water leaches through contaminated soils and transports the contaminants to a lake or river. Indeed, dumps of

FIGURE 1



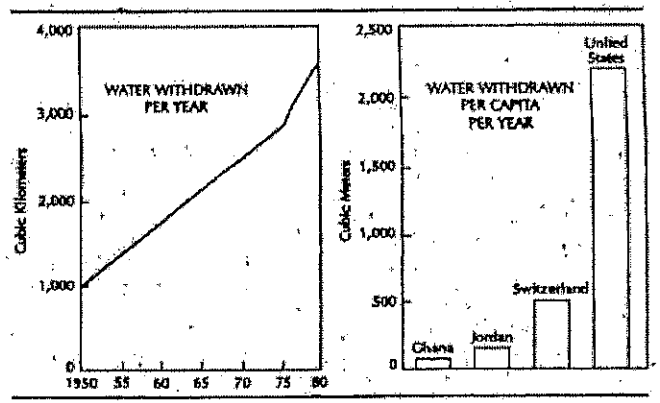
Note: Distribution of water on the planet is highly uneven. Most of it (97.41 percent) is in the oceans; only a small fraction (2.59 percent) is on the land. Even most of the water on land is largely unavailable, because it is sequestered in the form of ice and snow or as groundwater; only a tiny amount (.014 percent) of the earth's total water is readily available to human beings and other organisms.

toxic chemical waste on land have become a serious source of groundwater and surface-water pollution. The metal drums containing the chemicals are nothing less than time bombs that will go off when they rust through. The incidents at Lekerkerk in the Netherlands and at Love Canal in the U.S. are indicators of the pollution of this kind going on worldwide in thousands of chemical-waste dumps.

Some pollutants enter the water cycle by way of the atmosphere. Probably best known among them is the acid that arises from the emission of nitrogen oxides and sulfur dioxide by industry and motor vehicles. Acid deposition, which can be "dry" (as when the gases make direct contact with soil or vegetation) or "wet" (when the acid is dissolved in rain), is causing acidification of low-alkalinity lakes throughout the industrialized world. The acid precipitation also leaches certain positively charged ions out of the soil, and in some rivers and lakes ions can reach concentrations that kill fish.

In areas of intensive animal farming, ammonia released from manure is partly introduced into the atmosphere and partly converted by soil microbes into soluble nitrates in the soil. Since nitrate has high mobility (it is soluble in water and does not bind to soil particles), it has become one of the main pollutants of groundwater, often reaching concentrations that exceed guidelines established by the World Health Organization.

FIGURE 2



Note: Global water consumption is increasing (*left*), largely in response to a growing population and increasing per capita use by agriculture and industry. Although sufficient fresh water (9,000 cubic kilometers) is currently available, sound water management is necessary to ensure an adequate supply for the future. Per capita consumption rates vary drastically (*right*); the average American, for example, consumes more than 70 times as much water as the average resident of Ghana.

The wind can also carry pollutants—fly ash from coal-burning plants, for example, or sprayed pesticides. These can be carried great distances, eventually to be deposited on the surfaces of lakes or of rivers.

Another recently recognized aspect of water pollution is the accumulation of heavy metals, nutrients and toxic chemicals in the bottom mud in deltas and estuaries of highly polluted rivers, such as the Rhine. Because of their high pollution content, sediments that are dredged up cannot be used for such projects as landfills in populated or agricultural areas. Moreover, there is always the danger that natural processes or human activity will trigger chemical reactions that mobilize the pollutants by rendering them soluble, thus allowing them to spread over great distances.

The quality of inland waters depends not only on the amount of waste generated but also on the decontamination measures that have been put into effect. The degree of success in the battle for water quality differs from country to country, but it can be generalized into a conceptual formula proposed by Werner Stumm and his co-workers of the Swiss Federal Institute for Water Resources and Water Pollution Control in Zurich. The formula holds that the contamination load of a river basin depends on the population in the basin, the per capita gross national product, the effectiveness of decontamination and the amount of river discharge.

Most rivers in the industrialized world, where the population and per capita GNP are stable and decontamination procedures tend to be fairly effective, are nonetheless polluted by both traditional and industrial wastes. Yet some stabilization—if not improvement—of pollution levels was reported in the early 1980's. (Methods for treatment of traditional wastes consist mostly of sedimentation and aerobic and anaerobic microbial degradation, which are intensified forms of natural self-purification.) Methods for degrading inorganic pollutants such as metals and toxic chemicals, although improving, have not been as promising.

Where increasing industrial activity in a river basin has been matched by increasing waste treatment, a decent level of water quality can be maintained. Yet the balance between contamination and decontamination is a precarious one. A serious accidental discharge, such as the one that followed a 1986 fire at a Sandoz factory on the Rhine in Switzerland, is enough to wipe out large numbers of aquatic organisms and force drinking-water purification plants to close their intakes downstream from the accident.

In most newly industrializing countries both organic and industrial river pollution are on the increase, since the annual per capita GNP is rising quickly (as is the population, to a lesser extent) and decontamination efforts are often neglected. In these countries industrialization has had higher priority than reduction of pollution. As a consequence, in some regions (East Asia, for example), degradation of water resources is now considered the gravest environmental problem.

In less developed countries, where the population is growing and where waste treatment is practically non-existent, water pollution by organic wastes is widespread. As a result, millions of people—and children in particular—die each year from water-related diseases that can be prevented by proper sanitation facilities. These countries still suffer from diseases eradicated in the West long ago. Although the United Nations declared the 1980's to be the International Drinking Water Supply and Sanitation Decade and instituted a program to provide safe drinking water and appropriate sanitation for all by 1990, much remains to be done before the program's ambitious goals are met. Some progress has nonetheless been made in several countries, including Mexico, Indonesia and Ghana.

The quality of the water in lakes is comparable to that in rivers. Thousands of lakes, including some large ones, are currently being subjected to acidification or to eutrophication: the process in which large inputs of nutrients, particularly phosphates, lead to the excessive growth of algae. When the overabundant algae die, their microbial degradation consumes most of the dissolved oxygen in the water, vastly reducing the water's capacity to support life. Experience in Europe and North America has shown that the restoration of lakes is possible—at a price—but that the process takes several years. Liming is effective against acidification; flushing out the excess nutrients and restricting the further inflow of nutrients helps to reduce eutrophication.

Although pollution of rivers and lakes is potentially reversible, that is not the case for groundwater. Actually, little is known about the quality of the earth's vast groundwater reserves, except in those instances where particular aquifers are being actively exploited. In Europe and the U.S., where groundwater represents a significant source of fresh water, between 5 and 10 percent of all wells examined are found to have nitrate levels higher than the maximum recommended value of 45 milligrams per liter. Many organic pollutants find their way into groundwater as seepage from waste dumps, leakage from sewers and fuel tanks or as runoff from agricultural land or paved surfaces in proliferating urban and suburban areas.

Because groundwater is cut off from the atmosphere's oxygen supply, its capacity for self-purification is very low: the microbes that normally break down organic pollutants need oxygen to do their job. Prevention of contamination is the only rational approach—particularly for the developing world, where increased reliance on vast groundwater reserves is likely.

The oceans are part of the world's "commons," exploited by many countries and the responsibility of none and therefore all the more difficult to safeguard. More than half of the world's people live on seacoasts, in river deltas and along estuaries and river mouths, and some 90 percent of the marine fish harvest is caught within 320 kilometers of the shore. Every year some 13 billion tons of silt are dumped into coastal zones at the mouths of rivers. Although most of those sediments would have found their way into the ocean anyway, a growing part of the accumulating silt can be attributed to erosion and deforestation caused by human intervention. Depending on the particular agricultural and industrial activities in the catchment area, a coastal zone can be both fertilized and polluted by the silt and dissolved materials that reach it.

The coastal zone is the site of important physicochemical reactions between saltwater and freshwater flows; it is the zone of highest biological productivity, supporting marine life ranging from plankton to fish, turtles and whales. Aquaculture in the coastal zone now produces some 10 percent of the world's fish harvest. The 240,000 square kilometers of coastal mangrove forest are essential habitats for many economically important fish species during part of their life cycle, and they also provide timber and firewood; reed and cypress swamps are other examples of biologically rich coastal wetlands. Finally, of course, coastal zones support a highly profitable tourist industry and include a growing number of protected areas, such as the Great Barrier Reef Marine Park in Australia.

Aside from river discharges, diffuse runoff, atmospheric transport, waste dumping or burning at sea, offshore mining and shipping accidents are the primary ways that some 20 billion tons of dissolved and suspended matter reach the ocean, where they exert their initial effect on the coastal zone.

Polychlorinated biphenyls (PCB's) and other persistent toxic chemicals, including DDT and heavy-metal compounds, have already spread throughout the world's marine ecosystems, in part through gradual accumulation in the food chain. A ban on the use of DDT and PCB's has been enforced for some 10 years in the industrialized countries and has reduced the concentration of such chemicals in the marine life of North American and European coastal waters. The chemicals are, however, still being used and injected into the marine environment in many tropical regions.

Ocean currents are also vehicles for the transport of trash and pollutants. Examples are the nondegradable plastic bottles, pellets and containers that now commonly litter beaches and the ocean's surface. They cause the death of thousands of birds, fish and marine mammals that mistake them for food or get entangled in them. Less spectacular but possibly more serious are the chemical and biological processes (as yet poorly understood) whereby toxic substances such as radioactive wastes are distributed and accumulated.

Excessive sewage discharges from coastal urban areas lead to eutrophication of coastal waters, which can change the composition of plankton populations. The plankton, provided with abundant nutrients in the sewage, may experience rapid population growth, which depletes the supply of available oxygen and so leads to fish kills. Moreover, the presence of pathogenic bacteria in sewage has forced the closing of many kilometers of beaches to swimmers and has led to prohibitions on the harvesting of shellfish, which concentrate the bacteria in their tissues.

About one tenth of 1 percent of the world's total annual oil production —some five million tons a year, or more than one gram per 100 square meters of the ocean's surface—finds its way to the ocean. Large areas of the ocean would be covered with oil accumulated over the past decades were it not for the fact that the oil eventually evaporates or is degraded by bacteria. Although petroleum is almost entirely biodegradable, it takes the microbes that break it down a long time to accomplish the task, because their activity is limited by the low nutrient concentrations in seawater. In the meantime an oil spill's effects are lethal for a variety of plankton, fish larvae and shellfish, as well as for such larger animals as birds and marine mammals.

It is clear that the quality of the water in coastal zones is seriously endangered and that damage to fisheries and marine wildlife is widespread. Regional seas such as the Baltic and the Mediterranean, which have more coastline per square kilometer than the high seas do, suffer more from water pollution. Their poor condition demonstrates what may happen in the future to the larger oceans of the world.

Human activity is clearly responsible for widespread damage to marine ecosystems. What is not firmly established is how quickly toxic substances can accumulate in marine organisms or whether such accumulation is reversible. Nor has it been determined precisely how synthetic chemicals are transported through the oceans and what the likelihood is that toxic substances in bottom sediments will find their way into the human food supply. Yet experience so far dictates utmost caution, the more so because restoration of the oceans is incomparably more difficult than that of lakes and inland seas, if not impossible.

Some management of water resources—of both their quantity and quality—is now widely practiced all over the world, but the results, particularly in quality control, have been inadequate. All signals point to further deterioration in the quality of fresh and marine waters unless aggressive management programs are instituted.

Many of the guiding principles in water management have evolved from past experience and are well known, and yet their application has lagged. Above all, the need for an integrated approach has become apparent. In every river or lake basin, socioeconomic and environmental aspirations must be orchestrated so that human settlements, industry, energy production, agriculture, forests, fisheries and wildlife can coexist. In many cases varied interests are not necessarily in conflict; they can be synergistic. Erosion control, for example, goes hand in hand with reforestation, flood prevention and water conservation.

An integrated approach calls, of course, for closer cooperation at the governmental and intergovernmental level; it goes against the historical allocation of different tasks to different agencies. In many countries water supply and sanitation are handled by separate departments. Departmental budgets are isolated by money-tight walls, making it hard to balance investments made by one department with any resulting gains or savings accrued to another.

Such obstacles are even more formidable in an international setting. A country is unlikely to make significant investments in the decontamination of a river's water if it is other countries, downstream, that are likely to reap the benefits. The less developed countries may actually have a better opportunity to make progress here than the developed ones, where vested interests have entrenched themselves in rigid administrative structures. The United Nations Environmental Program (UNEP), for example, has drawn up an action plan for the Zambezi River based largely on principles of integrated management.

A water-management project should lean toward increasing the efficiency of water consumption rather than toward increasing the supply of water. To increase the supply is often more costly, and in any case it merely postpones a crisis. Indeed, because many countries are already overtaxing their water reserves, increasing efficiency is the only solution in some cases. Irrigation, for example, is terribly inefficient as it is practiced in most countries. Averaged over the world, only about 37 percent of all irrigation water is taken up by agricultural crops; the rest is never absorbed by the plants and can be considered lost. New microirrigation techniques, by which perforated pipes deliver water directly to the plants, provide great opportunities for water conservation, making it possible to expand irrigated fields without building new dams.

The mining of groundwater in order to increase supply should, of course, be avoided at all costs—unless it can be guaranteed that the aquifer from which the water is taken will be replenished. The protection of groundwater quality also deserves special attention. Government officials are more likely to implement pollution-control measures when they (or their constituents) are presented with highly visible signs of pollution, such as rubbish washed onto a beach. Hidden as it is from view, groundwater can therefore become polluted gradually without eliciting an outcry from the public until it is too late to reverse the damage wrought by the pollution.

It has also become apparent that the prevention of pollution, and the restoration of bodies of water that are already polluted, should gradually take precedence over the development of purification technologies. Water-purifying technology is becoming more complex and costly as the number of pollutants in water increases; the money spent on removing contaminants from drinking water would be better spent on preventing the contaminants from entering the

For that reason "end of pipe" remedies for industrial water pollution should be replaced by recycling and reuse. Factories designed to minimize water pollution through waste reduction are often more economic than those that construct their own waste-water treatment plants in order to meet environmental standards. Factories that integrate pollution-control techniques are also likely to be more acceptable to an environmentally conscious populace. As Peter Donath of the Ciba-Geigy Corporation, one of the world's largest chemical companies, said at last year's International Rhine Conference, "Only with environmentally sound products and manufacturing processes will the chemical industry be able to maintain social acceptability in the future." As an example of this new trend in chemical engineering, he cited a novel process for the production of naphthalene sulfonic acids that reduces pollution by more than 90 percent.

Pollution of a river or a regional sea is, of course, more easily perceived than the pollution of the oceans, which are much larger; it is not surprising that the UNEP has already established pollution-control programs for 10 regional seas. Although such programs are a good start, they need to be followed up with protection of the oceans in general. A recent step in this direction is an international agreement forbidding the discarding of plastics from ships, which became effective at the beginning of this year. Other existing international conventions regulating marine resources need to be improved by backing them up with better monitoring schemes and enforcement measures.

Parallel with the need for improved water-resources management is the need for more research on the hydrosphere. For example, ecological and toxicologic studies of marine life are badly needed if we are to improve the husbandry of the oceans and gain better understanding of the ecological effects of long-lived pollutants in ocean waters.

Many aspects of the hydrological cycle, including the fluxes between its compartments and the extent of groundwater reserves, are not accurately known. These problems and others are currently being addressed by the International Hydrological Program of the United Nations Educational, Scientific and Cultural Organization. Moreover, major international research programs to study the interactions between climate and the hydrological cycle have recently been launched by the UNEP as well as by the World Health Organization and the nongovernmental International Council of Scientific Unions.

Predicting what is likely to happen if sound principles of water management are not vigorously implemented is all too easy. We have already seen rivers turn into sewers and lakes into cesspools. People die from drinking contaminated water, pollution washes ashore on recreational beaches, fish are poisoned by heavy metals and wildlife habitats are destroyed. A laissez-faire approach to water management will spell more of the same—on a grander scale. One can only hope recognition of that fact will spur governments and people into action.