REMARKS

TALES OF FRENCH FRIES AND BOTTLED WATER: THE ENVIRONMENTAL CONSEQUENCES OF GROUNDWATER PUMPING

BY

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Good evening! It's great to be back at Lewis & Clark. I have a number of dear friends on the faculty, and I've been here several times in recent years. I always enjoy my visit. Tonight I'm going to talk with you about groundwater. This is a daunting topic, but groundwater deserves special attention as a critical environmental issue. Let's start with an overview of groundwater use in the United States. The following statistics are pretty familiar, yet immensely sobering. We know that farmers use most of our water, about two-thirds in the United States, but consider that total groundwater usage exceeded 40 *trillion* gallons in the year 2000. Groundwater now constitutes more than 25% of the nation's supply, and over half of us in the United States drink groundwater. Since 2000, the United States has experienced unbelievable growth and sustained drought. Farmers, cities, homeowners, and mines have searched for new supplies, and have almost always settled

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on groundwater. Though staggering, these are the best statistics available from the United States Geological Survey, and they are woefully out of date.

I next want to offer an overview of water law. There is a profound disconnect between what the legal system permits and what the science of hydrology teaches. In the American East, the use of surface water is governed by the doctrine of riparian water rights. If you own a piece of property on a lake or a river, you have water rights to that lake or river. They are shared water rights—correlative rights—because you and your fellow riparian property owners share the common resource. In the American West, settlers developed a different rule—the prior appropriation doctrine. The motivation for that doctrine is sometimes attributed to the aridity of the West, but other systems used different rules. The Church of Jesus Christ of Latter Day Saints (the Mormons), Native American communities, and acequias in Northern New Mexico did it differently. The European settlers who moved west thought of water like other natural resources as something to be used instrumentally, productively.

The prior appropriation doctrine began in California in the 1850s, during the gold rush days. Miners found out that it took a lot of water to mine gold. They realized they needed to develop a system of rules to figure out which miner had rights to what water. There's a wonderful irony in this, because, if you think about it, these miners were thieves. They were stealing gold. Whether they were stealing from the federal government, the native peoples, or Spanish-speaking people is a fair topic to debate, but it definitely wasn't the miners' gold. Yet, the first thing these thieves did was to set up a legal system. So, the prior appropriation doctrine (first-in-time, first-in-right) awards rights to use a specific quantity of water with a specific diversion point, date, and purpose. That's the prior appropriation system.

Now comes the disconnect. When we shift from surface water to groundwater, the rules change, though not in every state. Oregon and a few other states have a version of the prior appropriation doctrine for groundwater as well as surface water, which integrates the two systems. Other states govern groundwater with a right of capture. Like the first case you read in property, *Pierson v. Post*,[1] involving wild animals, the right of capture considers groundwater a wild resource. If you can get it out of the ground, it's yours. Most states have a third rule, the reasonable use doctrine, which sounds good, but is an oxymoron. It allows a person to pump a limitless quantity of water as long as it is for a beneficial use. However, anything can be a beneficial use. The right of capture and the reasonable use doctrine epitomize the tragedy of the commons. Consider an aquifer as a giant milkshake glass. What the right of capture and the reasonable use doctrine permits is a limitless number of straws in the single glass. This is an absolutely maniacal way to run a system, and profound consequences can result from this. Eventually you run out of water; the finite quantity in the glass will be exhausted. Because the rules give everyone an incentive to put a straw in the glass, the supply is threatened.

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[1] 3 Cai. Cas. 175 (N.Y. Sup. Ct. 1805).

That is what has happened with the Ogallala Aquifer. It stretches from the Dakotas in the north all the way down to the Texas Panhandle in the south. It had abundant groundwater resources, so much so that the area became the bread basket of the United States. However, the groundwater table has plummeted to such an extent that some farms have had to go back to dry land farming, creating a great deal of concern about the economic viability of the region. That's what happens when you allow limitless access to a common pool of resources; you will eventually run out.

Even if you don't run out, you've got other problems along the way, one of which is increased energy costs. Those who hike know that every time you put that one quart Nalgene bottle in your bag, backpack, or daypack, you're adding two pounds of liquid. In the West we don't talk about water in terms of quarts or gallons. We talk about an acre-foot of water, which is the amount of water that it takes to cover an acre of land to the depth of 12 inches. That's 325,000 gallons. 325,000 gallons weighs 1,358 tons. If you're a farmer and you're pumping from 500 feet below the surface of the ground, you're looking at multi-thousand dollar electric bills for each well, each month. That's more than enough to drive farmers out of business.

As the water table declines, so does the water quality. This seems to be a function of the Earth's internal temperature rising as you pump from deeper levels where the water is warmer. Warmer water allows some nasty, naturally occurring chemicals to dissolve, such as fluoride, arsenic, and radon. Then there's the problem of salt water intrusion along all coastal areas. There is no place around, except perhaps the Oregon coast, that does not deal with this problem. Groundwater pumping causes salt water to migrate laterally and contaminate the potable supply.

Then there's the problem of subsidence. The surface level in parts of California and Arizona has dropped since 1925. How has that happened? Remember the last time you went to the supermarket and bought a box of Kellogg's Corn Flakes? You brought it home, opened it up, and your first thought was, "Kellogg's ripped me off." Before you had eaten one bowl of cereal, it was a third gone. If Kellogg's had been kind enough to have added two cups of milk to the box of cornflakes, they'd be way up to the top of the box. But if you take out the milk, the cornflakes settle. That's subsidence: remove the water and the land settles.

Other people have written about subsidence and groundwater intrusion. *Water Follies*[2] is the first book ever published to focus on the environmental consequences of groundwater pumping: impacts on our surface waters, our lakes, our rivers, our creeks, our wetlands, and our estuaries. Let's start with Tucson, Arizona. As you drive west on Speedway Boulevard, there is a sign that reads: "Santa Cruz River." Tourists look over and start laughing. It's absolutely dry. It's not a river; it's a dry sand bar. Tourists think Tucson residents have been in the sun too long. But the sign makes sense if you look at it in historic terms. In 1942, there was a river at this location, flowing

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[2] ROBERT GLENNON, WATER FOLLIES: GROUNDWATER PUMPING AND THE FATE OF AMERICA'S FRESH WATERS (2002).

water and an immense cottonwood and willow gallery forest. But by 1989, nothing was left. All the trees were gone; all the water was gone; all these changes are a result of groundwater pumping.

How did this happen? The basic science of hydrology can be summed up with one principle: water only moves by the force of energy. The energy can come from the sun, evaporating water off of oceans or lakes. The energy can come from wind, as the water moves across the sky. The energy can come from gravity as water precipitates in the form of rain or snow. The energy can come from gravity as water flows down over the surface of the ground. It can come from gravity as water infiltrates the ground. It also comes from gravity as the water makes its way downhill to provide flow to the river. If it hasn't rained recently, water makes its way into a river from the ground. The water then flows laterally, subsurface to provide flows to our rivers and streams. A healthy river with a water table above the river stage supports the river with groundwater. But if the water table adjacent to the stream is lower, the water flows in the opposite direction. This is gravity—nothing more, nothing less. Water seeks the lowest ground and flows to the lowest point. When we drill groundwater wells, we add another phenomenon. Groundwater wells intercept water that is on the way to the water course, but because of the pumping, will never arrive at the water course.

Another Arizona example involves the San Pedro River in southeastern Arizona. The San Pedro River is one of the fabulous birding places in North America. It's the meeting point of the southernmost stopping point for many species of Canadian and northern U.S. birds and the northernmost stopping point for many birds from South and Central America. It's an extraordinary place and the birds come due to the San Pedro River. Growth is out of control near the San Pedro. Whether it will go the way of the Santa Cruz River in Tucson is unknown, but in August 2005, the San Pedro went dry for the first time in recorded history.

My message today is not just about Arizona, arid lands, or the American West. The environmental consequences of groundwater pumping are a national, and indeed, an international problem. My book happens to be about the United States. Let's first turn to the Midwest. I would like to share with you some stories of water follies. The first one occurs in the state of Wisconsin. Wisconsin is a state with great natural resources. Minnesota brags about having 10,000 lakes. Wisconsin has 15,000 lakes and seven to eight thousand miles of rivers. They have an active citizenry—the tradition of La Follette Progressivism is alive and well in Wisconsin— reflected in a major campaign to protect the Mecan River.

In the late Nineteenth century, the State of Wisconsin set out to protect the Mecan River. The state bought up huge sections of the river, rehabilitated portions, and obtained conservation easements from neighboring landowners. As a consequence, the river is a blue-ribbon trout stream with naturally reproducing strains of brook, brown, and rainbow trout. Yet it faced a threat from a most unlikely source: bottled water. Think about the concept of bottled water. Where did it come from? How did it

overwhelm us? No one used to drink bottled water in the United States, except perhaps at the office cooler, where you shared gossip or a dirty joke, or at Italian restaurants, or maybe in Berkeley. Now everyone drinks bottled water. This consumer craze has taken over. In my classroom, next to every laptop is a bottle of water. You go to the gym and everyone on the Stairmaster has a bottle of water. In fact, Stairmasters are now made with a place for you to put the bottle of water. Go to movie theaters and bottled water is more expensive than the popcorn! Bottled water now sells for more money than milk, oil, gasoline, or things made with water, like Coke.

Humans have a limitless capacity to deny reality. So what's bottled water got to do with the Mecan River? It has to do with Perrier, a French company that sells green bottles of spring water. Perrier's U.S. company, now called Nestlé Waters of North America, is a subsidiary of Nestlé, the largest food manufacturer in the world, and Nestlé Waters of North America is the largest bottler of water in the United States. Nestlé may not be a familiar brand of bottled water to you, but the company sells Arrowhead, Calistoga, Ice Mountain, Poland Spring, Zephyrhill and Osarka. They have fourteen different brands and a 32% market share of the bottled water industry in the United States. The company has decided for marketing reasons that American consumers will find greater cachet, and therefore pay more, for water that is labeled "spring water" rather than "artesian water," "ground water," filtered water," or any of the other FDA-approved labels. To sell water as "spring water," you must locate the well that pumps the water next to the spring.

That brings us back to Wisconsin. Nestlé wanted to drill a well next to a spring that flows into the Mecan River. The state of Wisconsin has the reasonable use doctrine. There was nothing the state could do to prevent Nestlé from drilling a well. Nestlé's well was going to pump between five and six hundred gallons per minute, every minute, of every hour, of every day in the year. That's 272 million gallons of water a year that they put in bottles and take away. The well was going to be located sixty feet away from the spring. The spring carried a flow of between three and five cubic feet per second, a spring you can easily step over. The question was, "What's this going to do to the spring?" The answer, according to the Perrier hydrologist, was nothing.

I thought this was kind of a surprising conclusion. I went back to the University of Arizona and talked with Tom Maddock, a hydrologist. I said, "The Nestlé guy says this isn't going to impact the spring." Tom replied, "He's not a hydrologist, he's a hydrostitute." There are some honest debates about what the hydrologic model shows, about parameters, calibrations, and other factors. There are arguments that don't meet what lawyers call the "straight face" test: if you can't make an argument on behalf of your client without smiling, you probably ought to forget that argument. Nestlé's position doesn't meet the straight face test. It was absolutely absurd. The pumping would have devastated the spring. The reason why it's a water folly is that if Perrier had moved its well two miles away from the spring, the well would have produced water with the same chemical composition and had

negligible impact on the spring. However, the water wouldn't have fit the company's marketing strategy of selling spring water. American consumers' fetish for spring water drove a company to such extremes.

In the end, this particular deal didn't go through because the aggressive citizenry of Wisconsin said it was unacceptable. The uproar from the local community was finally enough to convince Nestlé to go next door to Michigan and open a bottling plant there. That plant has now been challenged, as have proposed plants in Maine and California.

I want to turn now to Florida. Though Florida was once a swamp, those wetlands were drained long ago and they now have a water shortage problem. This is most improbable, because the state gets more than fifty inches of rain a year. On the west coast are the cities of Tampa and St. Petersburg: both big cities, both on peninsulas, both built out, both desperate for new water sources. In the 1970s and '80s, they went north and bought up huge tracts of rural land in Pasco County. Then they began to pump, and pump, and pump some more. Eventually they pumped so much that they created major problems, such as subsidence. This isn't Kellogg's Corn Flakes settling, this is Karst limestone. If you move water through limestone, you literally dissolve the structure. Scores of lakes in Florida, such as Crooked Lake, have dried up from groundwater pumping.

Consider the story of Steve and Kathy Monsees, Midwestern kids who were living in Florida. He was in the military and served in the first Gulf War. They liked Florida and decided to retire there. They bought a piece of property on a lake and built their retirement home. After his last posting from the Sudan in the early 1990s, they began living in their house on the lake. However, the lake became smaller and smaller until it finally dried up. Their retirement home on the lake had become mud flat property. At that point, they did what you are supposed to do in a democracy. They attended meetings, wrote letters, and tried to become informed about this issue. The utility just stonewalled them. Eventually it became obvious that these big well fields in Pasco County, right down the street from where their house was, had pumped all the water out from underneath them. At that point, the utility had a major public relations disaster. It had to do something. So the utility decided to refill the lake using groundwater. They pumped 375,000 gallons of water each day and dumped it into the lake, where it promptly percolated into the ground. It was like trying to keep water in a colander: madness.

The utility's engineers refused to recognize their folly, instead insisting their plan simply needed tweaking. They proposed to line the lake with an impermeable material and then dump the water in it. This is one of my favorite follies: engineers totally, blissfully ignorant. When the *Water Follies* book came out, Island Press received a twelve-page letter from the chief engineer, demanding that the book be taken off the market and defending the practice of refilling lakes as perfectly sound. Some people are clueless.

Let's move on to Texas. This story is about San Antonio, with its well-known River Walk. It's a vibrant downtown. The San Antonio River flows through, and boats go up and down the canals. There are fancy hotels,

restaurants, and boutiques. Mariachi bands entertain the tourists. It's become the greatest tourist attraction in Texas, outdrawing even the Alamo. There's only one problem. There is no river. The river you see is a complete illusion. It's the dry San Antonio River bed, into which the city dumps up to 10 million gallons a day of groundwater pumped from the Edwards Aquifer in order to create the economically useful fiction of a river. The city circulates the water around, supplements it as needed, and, once a year, drains it and removes the silverware and the beer bottles because the "tourists like it natural."

The City of San Antonio is the largest city in the United States that is 100% dependent on groundwater. They are desperate for supplies. This led to the realization that if the water in River Walk is such good water, why use it only once? So the city now serves it to customers, runs it through their waste water treatment plant, then dumps it into the river. Tourists don't seem to have noticed a change. It's still groundwater, but it's been used once. San Antonio has got to find new water supplies.

Until recently, Texas had the right of capture doctrine. Under this doctrine, why would I buy your water right when I can go right next to your place and put in a well and suck your water out? That's called "the American way." It's not very neighborly, but that's the right of capture. If you think about it, it's the very antithesis of a property right. It's akin to a circular firing squad, everyone's gun pointed in—a mass, self-destructive act.

Under the hammer of the Endangered Species Act,[3] because there are some endangered species in the springs that discharge from the Edwards Aquifer, a federal judge ordered the state to change things. The state created an authority to divide up water rights. This meant the possibility of doing some deals. So, San Antonio first approached a local kid who went into the water business. He teamed up with a slumlord from New Jersey to find water. The Edwards Aquifer is a very productive aquifer. The area gets rainstorms measured in feet. In some places, there's even artesian pressure. Imagine an oil well gusher going up in the air. That's artesian pressure. By golly, these guys hit it. They put in a well with a diameter of thirty inches, and it rumbled like a freight train and erupted. It sent a column of water forty-five feet straight up in the air with a diameter of thirty inches. This thing put out 43 million gallons of water a day. So the first thing these guys did—as religious people who were thankful for their blessings—was name the well Avé Maria #1. I could just see a whole rosary of Avé Marias: Avé Maria #17, Avé Maria #22. They were on to something really big. Then they had to figure out what to do with 43 million gallons of water a day. They decided to raise catfish. To put this in perspective, this is one-quarter of the needs of the SIXth largest city in the country, and these turkeys are growing catfish and polluting the local streams to boot. It was so over the top, even in Texas, that the city came in and bought them out for 10 million dollars. Water has a value we haven't appreciated.

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[3] Endangered Species Act of 1973, 16 U.S.C. §§ 1531–1544 (2000).

The city still needed more water so they turned to the panhandle—specifically Roberts County—and to a fellow by the name of T. Boone Pickens, quite a legendary character in Texas. Pickens said to San Antonio, "Look, you need water; I've got water. I'll sell you the water from beneath my ranch. I will pump it out and sell it to you." However, there was little water beneath his ranch. Remember the Ogallala Aquifer? That's where his ranch is. What he was really volunteering to do was to sell the water out from underneath his neighbors' ranches, because that's what the right of capture permits. Your pumping creates a gradient, and you just sort of drain this water from neighboring property, and sell it to San Antonio.

When we in the American West think about the Central Arizona Project, about moving water hundreds of miles and projects costing billions of dollars, we think blissfully about something else. That something else is the United States Treasury. We think about taxpayers in New Jersey who haven't a clue about western water projects. In Arizona, we think that the role of the federal government is to bring in wheelbarrows full of money, drop them, and then go away. We are independent, free spirits in Arizona. This project, however, didn't have any federal money, didn't have any state money, didn't have any local money. It had no government support whatsoever. Pickens was willing to put up a billion dollars of his own money to do this deal. Water has a value we haven't appreciated.

Let's turn to Minnesota, a great state with wonderful natural resources. This story is about McDonald's french fries. We've all eaten McDonald's french fries; the average American consumes thirty pounds of fries a year. This story is about Ray Kroc, the founder of McDonald's. He was a marketing genius who understood the whole idea of fries. If you want to make a great fry, you've got to start with a potato that has a high water content, because the process of making the fries is the process of extracting the water and replacing it with fat. That's why they taste so good: they contain lots of fat and taste good, especially with a lot of salt. So how does this relate to Minnesota?

It relates to Minnesota in that a sea change in water use in the United States is occurring as farmers in Minnesota are irrigating. Traditional dry-land farmers in the Midwest, the East, and the Southeast are now irrigating to get a higher yield from their crops. This story revolves around Ron Offutt, one of the largest potato growers in the United States, who also happens to be the largest John Deere dealer in the United States. What does potato farming have to do with the environment? It has to do with the Straight River.

The Straight River is a blue-ribbon trout stream threatened by using water to grow potatoes. Potatoes grow perfectly well elsewhere without the need for irrigation. Farmers have been growing potatoes in Maine for hundreds of years, and you can make fries with potatoes grown this way. But when you make fries without irrigation the potatoes could be slightly different, not the same. The next time you go to the supermarket, try to find real potatoes. They are mostly found in the frozen food section. You can find thirteen types of frozen french fries—more models than GM has. Every

potato is the same as the next one: same diameter, same color, and same length, which for McDonald's purposes, is most important. In the 1980s, McDonald's went from selling french fries in little waxed paper bags, to selling them in the hard-sided boxes that we now know well—Super Sized. From that point on, McDonald's would only buy from farmers who irrigated, because irrigation produces what are called in the trade, "industrial potatoes." They have the same uniformity as a wristwatch or a computer, and are just the right length to stick out of that Super Sized carton and be grabbed between your thumb and forefinger and dipped in catsup. That's a water folly. Potatoes can grow perfectly well without irrigation. In fact, they do so for markets in Japan, and consumers in Japan are notoriously fastidious about their foods. Yet, in America all our fries are the same length, perfectly white and blemish-free.

As a final story, let's return to Arizona and the Grand Canyon, a fabulous place. But we are loving the Canyon to death. Every year five to six million of us visit the Grand Canyon, and at this point the place has problems. There's haze over the Canyon from the air pollution from mining operations, traffic congestion is a problem, and the housing facilities for park employees and concessionaires are in appalling shape. We have to do better by this crown jewel. We simply must.

This story is about the future of water. It begins with a Scottsdale, Arizona developer who wants to do a deal. In the little town of Tusayan, just outside Grand Canyon National Park, he wants to do a land swap with the Forest Service. He owns 2,200 acres of land inside the National Forest, and he wants to exchange that land for 262 acres of land in the town of Tusayan owned by the Forest Service. The proposal was for a mixed-use development with some condos, some motel units and some commercial sites, a Native American craft center, and housing for park employees. He proposed to supply the project with groundwater. To do this swap required preparation of an environmental impact statement (EIS). The EIS revealed that using groundwater would reduce the flow in Havasu Spring and in Indian Garden Creek.

Indian Garden Creek is a perennial creek which supports an amazing cottonwood oasis that you encounter halfway between the South Canyon rim and the river. It's a place to stop, fill up your canteen, relax in the shade, and enjoy the splendor of the Canyon. Those who have rafted the Canyon know that Havasu Spring comes in two-thirds of the way down the Canyon, river left. It's a turquoise river with turquoise waterfalls. It's an extraordinary place. It looks like it should be in the Caribbean, not in Arizona. When the EIS was released, indicating that Indian Garden Creek and Havasu Spring would be affected by the proposed groundwater pumping, it generated an angry reaction. How could you think of doing something that would have that kind of impact on the Grand Canyon! The developer knew this was not an idea that merely needed tweaking. It was back to the drawing table.

The developer pulled together the major stakeholders: Grand Canyon National Park, the Forest Service, the two principal tribes, the Grand Canyon Trust, and the National Parks and Conservation Association. He

brought these players to the table to figure out a different water supply. They proposed having the developer buy some Colorado River water rights, which he would divert at Topock. Topock is further south, on the western border of Arizona. He would load water onto Burlington Northern tankers, and move the water 180 miles by railroad to Williams, where he would offload the water. At that point, he would put the water in a pipeline that he would build for 15 million dollars and move it fifty miles from Williams to Tusayan, where he would use the water.

This was going to cost a lot of money. After adding up all the numbers, it came to 20,000 dollars per acre-foot of water. Farmers in the Welton-Mohawk Irrigation District in southwest Arizona, pay 15 dollars an acre-foot; across the border in California, farmers pay 15 dollars in the Imperial Irrigation District for that same Colorado River water. This was 20,000 dollar water. Farmers can't make a profit if they have to pay 20,000 dollars, even if they grew marijuana. The developer, bewildered by these numbers, gave them to his accountant who crunched them and said: "It's a go."

Let's stop thinking about water in terms of acre-feet and start thinking about water in terms of Nestlé. 20,000 dollar water ends up being six cents a gallon. It's just a cost of doing business for a development at the gateway to one of the grand splendors on earth. Water has a value we haven't appreciated.

The cause of these problems: population growth. That's the basis of every environmental problem. Every hour, the population of the state of California increases by about sixty people. The population of the United States is now 300 million, up 15 million in the last five years. Demographers predict we will hit 400 million by 2043. It's all about population.

The problem also involves a tragedy of the commons, brought about by the profound disconnect between principles of hydrology and legal rules. Hydrologists understand the problem: the laws are out of whack. We've got to break that relentless cycle. It is absolutely bewildering to think that we let anyone who wants, under the guise of property rights, just put more straws into the milkshake glass.

These stories are funny but also quite serious. The impact of groundwater pumping on the environment is hidden, and it occurs slowly over years or even decades. Groundwater pumping that has already occurred is going to have consequences on the nation's fresh waters in years to come. We must take action. The time is now. We need to recognize that water is both a public resource and has aspects of private property. We can and should encourage water conservation. Some places, such as Tucson, have already gone quite a ways down the path of conservation, but there are limits to what we can achieve through conservation.

What has not been done with water policy in the United States is to consider market- based solutions, price signals, and incentives. We need to tell every new user of water, if you want to put a straw in the glass and make the problem worse, then you've got to take some other straw out. You've got to buy a current user's right to use water. We will no longer permit you to

make the situation worse. This market process will help to move water from lower value to higher value uses.

We must also begin to price water appropriately. Most Americans pay more money for their cell phones and cable TV than for water. We need to raise the price of water. This is a very dicey political issue, but we need to begin a dialogue about how to structure water rates appropriately. Let's begin with a life-line rate. In the richest country in the history of the world, we can surely recognize a human right to water. But that amount of water, calculated at twelve to fifteen gallons per capita per day, only constitutes 1% of the total water use in the United States. That leaves the other 99% to be accounted for. That's where market forces can play a role, with voluntary transfers between willing sellers and willing buyers.

There is reason to be optimistic. Mother Nature is remarkably forgiving and regenerative, although we have treated her resources shamefully. If we can slightly redirect our water policy, there is reason to think that the springs will bubble and the rivers will flow.