DESALINATION
An Ocean of Problems

food&water watch

On the cover: A desalination plant in the Carribean.

About Food & Water Watch

Food & Water Watch is a nonprofit consumer organization that works to ensure clean water and safe food. We challenge the corporate control and abuse of our food and water resources by empowering people to take action and by transforming the public consciousness about what we eat and drink. Food & Water Watch works with grassroots organizations around the world to create an economically and environmentally viable future. Through research, public and policymaker education, media and lobbying, we advocate policies that guarantee safe, wholesome food produced in a humane and sustainable manner, and public, rather than private, control of water resources including oceans, rivers and groundwater.

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Executive Summary

As local, state and federal governments in the United States increasingly fear drought and water shortages, private corporations are marketing ocean desalination as the solution. They promise that reverse osmosis technology can turn the ocean into a reliable source of drinking water by removing the salt from seawater. While they offer their product for two to four times the cost of other water sources, they fail to advertise the toxic chemicals, marine life damage, carbon emissions and other social and environmental ills that come along with it.

Food & Water Watch investigated the current state of desalination technology and concluded that the large financial, social and environmental costs of ocean desalination technology far outweigh the small potential benefits — especially when compared to other alternatives. When evaluating desalination as a water supply option, policymakers should choose cheaper, safer options such as implementing conservation measures. These programs will not return a profit for private corporations, but they will preserve and protect our nation's freshwater and ocean resources for future generations.

This report, *Desalination: An Ocean of Problems*, shows why ocean desalination is a risky water supply option and how policymakers can better provide the public with safe, affordable water.

Findings

Alternatives abound.

When communities and policymakers focus on ocean desalination, they are ignoring other, better options.

Smart water agencies are making great strides in adopting efficient water management practices such as conservation and reuse. Water efficiency programs are consistently less expensive and more effective than taking salt out of water, and without the associated risks. California, for example, could save a full third of its current water use, at a cost 85 percent lower than using new sources of water.

Further, our nation's water systems lose 6 billion gallons of water per day due to problems such as leaking pipes. Utilities cannot account for this water because many do not have the resources to implement comprehensive leak monitoring programs. Meanwhile, all of the desalination plants in the United States today operating at their full capacity could only produce a quarter of this unaccounted for water.

Ocean desalination is expensive.

Most communities in the United States cannot afford desalinated seawater. Although the price tag varies by region, and the true price is often hidden by corporate underestimates and government subsidies, it is consistently more expensive than traditional options and much more costly than conservation and redistribution programs — two to almost four times as costly. Moreover, the price of ocean desalination is unlikely to decrease in the near future. Implementing an expensive water supply would hike up prices, which would disproportionately burden the very citizens who can least afford higher bills.

Ocean desalination will provide little benefit and has a poor track record.

The majority of existing desalination plants in the United States desalt brackish river or ground water, not ocean water, and usually for very small scale industrial purposes.

Even if all of the nation's small desalination plants operated at full capacity, they would create only enough water to supply 0.4 percent of the nation's current water use. Food & Water Watch calculated that if all of the proposed plants in California functioned at their full capacity, the additional water would only be enough for everyone in California to take one extra three-minute shower a day. If all financial, environmental and social impacts were factored in, this three-minute shower likely would be the most expensive shower most citizens ever took.

Further, that assumes the plants would function. Many larger plants currently built for municipal drinking water purposes do not operate at their stated capacity, if they operate at all. In fact, the first and only large-scale ocean desalination plant operating for municipal use in the United States was fraught with failures and now produces less water at a cost that is 43 percent higher than the originally promised price — $110 million.

Ocean desalination invites corporate control and abuse of our water supply.

The push for ocean desalination is led by private corporations that plan to sell desalted ocean water to the public at a premium. This private ownership allows the people who control our vital resources to put their bottom line before the public interest. Private companies do not conduct the same rigorous, public review of social and environmental impacts as government agencies and are not sensitive to the social and environmental injustice that the public sector must address.

Ocean desalination endangers the environment and public health.

While numbers do a good job of illustrating the pure financial cost of desalination, they do not accurately reflect the full expense. Food & Water Watch found that additional costs borne by the public include damage to the environment, danger to the public health and other external considerations.

Ocean desalination could contribute to global warming.

Ironically, while desalination is supposed to improve water shortages, its emissions could actually hasten the global warming that will alter precipitation patterns and further strain existing water supplies. The greenhouse gas pollution from the industrial seawater desalination plants dwarfs emissions from other water supply options such as conservation and reuse. Seawater desalination in California, for example, could consume nine times as much energy as surface water treatment and 14 times as much energy as groundwater production.

Ocean desalination threatens fisheries and marine environments.

Further, on its way into a plant, the ocean water brings with it billions of fish and other organisms that die in the machinery. This results in millions of dollars of lost fishing revenue and a great loss of marine life.

Then, only a portion of the ocean water that enters the plant actually reaches the consumer.

The remaining water ends up as a highly concentrated solution that contains both the salt from the ocean and an array of chemicals from the industrial process – which is released right back into the ocean, toxins and all.

Ocean desalination poses a risk to human health.

The portion of the water that reaches the customer contains unregulated chemicals not present in normal drinking water, which endanger the public health. These contaminants include chemicals such as endocrine disruptors, pharmaceuticals, personal care products, and toxins from marine algae.

Ocean desalination promotes social and environmental injustice.

The price hikes due to expensive desalinated water disproportionately affect the very citizens who are least able to afford the higher water bills – the same citizens who are most likely to live near the plants and experience the noise and pollution from the technology.

Recommendations

• Citizens should encourage state, local, and federal decision-makers to abandon ocean desalination as a supply option and should instead implement comprehensive conservation measures. If ocean desalination is the best option, the plants should be publicly owned.

• Federal and state governments should not be subsidizing this technology. As a "growth sector," private companies have more than enough means to support their own research and development.

• New federal and state laws are needed to protect consumers, public health and coastal environments from ocean desalination.

“Desalination of the sea is not the answer to our water problems. It is survival technology, a life support system, an admission of the extent of our failure.” – John Archer

Introduction

Our water resources are in a sad state of repair. We have polluted our rivers and streams to the point where half can no longer sustain their critical functions,[1] our groundwater supplies are withdrawn faster than they are replaced and 36 states will likely face water shortages in only five years.[2] Already, states in the arid southwest are struggling to keep up with demand and the governor of California has declared a drought for the first time in 17 years.[3]

Years of mismanagement got us into this bind. In 2002, for example, a Florida task force recommended 51 water-saving measures that would significantly cut use. Yet, by 2007 not one of the recommendations had been enforced under state law.[4]

Further, our aging infrastructure loses billions of gallons of water every day just from leaking pipes.[5]

Now private industry is sliding in to city halls and county councils to offer new technologies as a quick fix to our problems — if only we pay them enough.

One such proposition that has gained media attention is ocean desalination — removing salt from seawater to make it drinkable. Companies market the idea that when faced with limited potable water on land, we can turn the ocean into a vast new drinking water resource. General Electric, for example, illustrates this message in a commercial which shows a boat load of rugged fishermen pulling blocks of bottled water from the sea, as if they were fish, and celebrating their new pure, fresh source of water.

Such marketing makes ocean desalination appear simple and easy. It is not. In reality, it involves huge plants, heavy machinery, lots of energy and extremely high financial, social and environmental costs.

While policymakers are distracted by these costly proposals, they are ignoring much less expensive, simpler and more effective programs. Studies show that conservation programs are cheaper than desalination, but without the negative effects. However, these programs are often ignored when desalination proposals are considered.

This is not wise policy. Rather than turning to the ocean, we should be looking at conserving and protecting our inland fresh water resources — because if we ever find ourselves looking to the ocean as our only remaining option, we truly will be facing a national water crisis.

As author John Archer wrote: "Desalination of the sea is not the answer to our water problems. It is survival technology, a life support system, an admission of the extent of our failure."[6]

This report, *Desalination: An Ocean of Problems*, explains the historical and political context of ocean desalination, why it's an unwise idea and how policymakers can pursue better options.

How We Got Here: The History of Ocean Desalination

Although using the ocean in our municipal water supply is a rather recent idea, desalination itself is not new. In fact, some scholars say the Book of Exodus contains the first record of the technology, when it describes Moses turning bitter water into sweet water using a piece of wood.

Outside of the Bible, the ancient precursors to the desalination plants we know today used a method called distillation. In this process, salt water is heated to a boil, at which point some of it evaporates into steam. This steam is collected and cooled back to fresh water, while the salt remains behind in the boiling water. Early records of distillation go back to ancient Greece, when Aristotle described the sun's abilities to separate salt from water by making water vapor. Later, during the Renaissance, the renowned scientist Giovani Batista Della Porta took another step, turning brackish water into fresh water using a solar distillation unit. In 1872, a Swedish engineer built the first large solar distillation plant, in Las Salinas, Chile, to supply water for workers at a saltpeter and silver mine. His plant was made out of wood and covered with a single sheet of glass.[7]

Over time, distillation technologies evolved into industrial plants capable of producing large quantities of potable water. Unfortunately, they were extremely expensive, energy intensive and polluting — so much so that only extremely water-short and oil-wealthy regions were inclined to use them. Even today, nearly half the world's desalination capacity resides in the Middle East, and much of that uses distillation technology.[12]

The Technology

Modern desalination technologies fall into two major categories: distillation and membrane.

Distillation technologies separate salts and other minerals from the water by heating source water to generate steam. The salts and other minerals are heavier than the water, so they do not evaporate. While the salts and minerals remain in a liquid concentrate, the steam is collected and turned back into largely pure water.

Reverse Osmosis and other membrane technologies pass water through tiny holes in membranes that block the passage of larger salt and mineral molecules. The membranes are made out of synthetic materials such as cellulose, acetate and nylon.[8] Different membranes come with pores of different sizes, from microfiltration membranes that have holes sized 0.1-1 microns to RO membranes that have holes 0.0001 to 0.001 microns wide[9] — a distance 70,000 times smaller than a human hair.*

Distillation technologies account for 43 percent of desalinated water production worldwide.[10] In contrast, reverse osmosis and other membrane systems make up 96 percent of U.S. desalination systems and 100 percent of the systems in the United States that provide municipal drinking water.[11]

*See methodology section for calculation.

Large-scale distillation plants have always been far too energy-intensive and expensive to implement in the United States. However, World War II inspired the U.S. National Research Defense Committee to research new methods in order to provide fresh water to soldiers on Pacific Ocean Islands.[13] These efforts inspired a new technology: reverse osmosis.

Rather than heating water to separate salts, reverse osmosis pumps ocean water over synthetic membranes. These membranes contain microscopic holes that prevent the passage of salt and other dissolved solids. Today, the process is used in wastewater treatment and in home water filters.

On a larger scale, this desalination process has been used mostly for industrial purposes[14] and almost always to treat brackish ground water and river water, not ocean water.[15]

Today's proposed ocean desalination projects feature this newer, reverse osmosis technology. It was born between the 1950s and early 1970s, when the Department of the Interior spent over $1.5 billion dollars on desalination research. Since then, federal interest in the technology has waned. During the 1980s and 90s, the federal government funded desalination through other water programs, but without its initial enthusiasm. Most of the funding for desalination came from the Bureau of Reclamation, although other agencies have conducted desalination research.[16]

Now it is private industry, rather than government, championing the technology. In fact, the $10 million to $25 million dollars spent by the federal government in the last few years pales in comparison to the $100 million to $150 million per year spent on desalination research by private industry.[17]

Private corporations are investing heavily in the technology because desalination is a leading area of growth in the booming water market. Speculators predicted long ago that as the world's water resources dried up, water would become the next oil — a scarce resource and a highly profitable commodity. Today, global corporations are setting themselves up to sell water for a substantial profit. Already, the global water market is worth an estimated $400 billion, and the United States water market alone likely will hit $150 billion by 2010.[18]

Federal Support for Desalination[19]

1952: Saline Water Act of 1952 created the Office of Saline Water in the Department of the Interior.

1950s to early 1970s: OSW spent $1.5 billion leading the world in membrane technology research.

1974: OSW became the Office of Water Research and Technology.

1980s: Government limited its efforts to a small amount of research in the U.S. Geological Survey, sponsored by the Water Resources Act of 1984.

1996: After a 12-year break, the Water Desalination Act of 1996 revived federal funding in desalination projects with the Desalination and Water Purification Research and Development Program (DWPR).

1998-2006: $13 million went towards DWPR, while additional funds were spent on a Water Quality Improvement Center. Congressional earmarks allocated an additional $20 million for a Brackish Groundwater National Desalination Research Facility in New Mexico.

2003: Sandia National Laboratories and the Bureau of Reclamation created the Desalination and Water Purification Technology Roadmap to incorporate desalination into a national water strategy.

2005-2007: The National Research Council estimates that the federal government spent $23.6 million in 2005, $24.2 million in 2006 and $10.1 million in 2007 on desalination.

2008-present: There is no clear coordinated federal desalination program. Most federal funding for desalination comes from the U.S. Bureau of Reclamation, although Sandia National Laboratories and the National Science Foundation also contribute, and the Department of Energy, the U.S. Army and the Office of Naval Research have carried out their own studies. The National Research Council recommends that the federal government continue to spend $25 million a year, out of a total water research budget of $700 million, on desalination research.

Desalination is a key area of growth in this market. Recently, General Electric paid $1.1 billion for Ionics, a company that specializes in desalination plants and membranes.[20] Meanwhile, the Japanese firm Nitto Denko, Italian Impreglio, South Korean Doosan Heavy Industries and Construction, French Suez, German Siemens and Spanish Acciona all provide desalination products.[21] These companies probably hope to profit off of the substantial worldwide demand for new water sources. According to one estimate from the World Health Organization, Arab states alone will need $100 billion worth of desalination in the next 10 years in order to continue their present economic growth.[22]

Yet a closer examination reveals that ocean desalination remains a risky water supply option in the United States. Even significant advances have not made the technology a safe and affordable water option, especially when compared with other alternatives.

Ocean Desalination Is Expensive

Desalination proponents argue that ocean desalination is more affordable than ever before. This is true. Reverse osmosis is less expensive than distillation, and recent investments have decreased the price of membranes considerably. Moreover, in some regions, the cost of desalination is beginning to look comparable to that of other water supply options, especially as the costs of these sources have gone up. For example, in Southern California, desalinated water cost *30 times* as much as delivered water in the 1990s. By 2004, with delivered water prices skyrocketing, the desalinated water seemed to cost *only twice* as much,[23] although this calculation did not consider the additional cost of delivering the desalinated water. So the desalted water was still significantly more expensive, but the difference seemed less astronomical.

Further, desalination is often presented as more affordable than it really is because, as the National Research Council explains, "many estimates, especially in the lower range, include subsidies or do not account fully for all costs."[24] For

As people around the world are becoming more desperate for fresh water, global corporations are setting themselves up to sell water for a substantial profit.

The 20 Companies with the Biggest Shares* of the Desalination Market Are:[25]

1. Doosan (South Korea)
2. Veolia (France)
3. Fisia (Italy)
4. General Electric (United States)
5. Befesa (Spain)
6. Degremont (France)
7. Tedagua (Spain)
8. FCC (Spain)
9. Biwater (United Kingdom)
10. Inima (Spain)
11. IDE (Israel)
12. Kurita (Japan)
13. Nomura (Japan)
14. Acciona (Spain)
15. Hyflux (China)
16. Cadagna (Spain)
17. ITT (United States)
18. Siemens (Germany)
19. Mitsubishi (Japan)
20. AES (United States)

*Based on size of water bids (gal/day) won.

example, in Tampa Bay, Florida, the companies that bid to build a desalination plant promised unthinkably low prices largely because the Southwest Florida Management District promised $110 million — 90 percent of the estimated capital costs.[26] Likewise, five projects proposed in Southern California could qualify for subsidies from the Metropolitan Water District of Southern California.[27] So the quoted prices seem like a better deal than before, but citizens still end up paying for the more expensive projects through their taxes.

Still, the price has not come down enough to make ocean desalination affordable for the public water supply. As stated in a National Research Council report, the costs of desalination are still "quite high when compared with the costs of alternatives in most locales."[28] And of all desalination options, ocean desalination is the most expensive. The pro-desalination American Membrane Technology Association stated that existing traditional supplies cost $0.90 to $2.50 per 1,000 gallons produced. The cost of brackish desalination technologies, on the other hand, ranged from $1.50 to $3.00 for the same amount of water, and seawater desalination ranged from $3.00 to as much as $8.00 per 1,000 gallons produced.[29] Other authorities estimate a price range of seawater desalination in California from $3.00 per thousand gallons to as high as $8.35.[30]

The high cost prevents many utilities from implementing seawater desalination on a large scale. In Texas, for example, the Texas Water Development Board concluded that the state's first full-scale seawater desalination plant was "technically feasible," but the plan was abandoned in favor of a much smaller demonstration project because the Brownsville Public Utility Board could not cover the $182 million bill.[31]

Meanwhile, high costs are not just a problem for the utilities, but also for individual citizens. As one scholar pointed out, "reverse osmosis plants are a good option for affluent coastal communities where people have expensive homes and paying $100 a month for water is not that big a deal."[32] Realizing these costs, the town of Seabrook, New Hampshire decided that it could not afford a hike from $2.80 a gallon to $8.00 per gallon for desalinated water.[33]

Moreover, ocean desalination is unlikely to decrease in price any more in the near future. Reductions in membrane costs caused the recent steep fall in total price. However, the National Research Council reports that the membrane is now a relatively small part of the total cost.[34] So even significant improvements in membrane technologies will do little to bring the total price down further.

Now, aside from capital and operating costs, the most expensive factor for seawater desalination is the cost of energy.[35] Pumping water across membranes to remove salt takes a lot of energy. Unless existing technology becomes significantly more energy efficient, the total expense of desalination is not likely to decrease. In fact, with oil prices rising around the globe, it is possible that the technology will remain prohibitively expensive even if the equipment substantially improves.[36]

Because it is so expensive, the companies that present desalination as a solution are seeking federal and state subsidies for their projects. For example, the New Water Supply Coalition, formerly the U.S. Desalination Coalition, is an

association of private companies and public utilities that lobbies the federal government for subsidies for desalination projects in the form of tax credits, as part of "Clean Renewable Water Supply" legislation.[37] Meanwhile, on a local level, the same types of companies market their plants to state and local governments as an essential, and now cheaper, new water supply option.

Ocean Desalination Invites Corporate Control and Abuse of Our Water Supply

So with all of these drawbacks, why are we even considering ocean desalination? Many desalination projects are built and owned by private companies that see a huge opportunity to profit. For example, United Water New York is attempting to gain support for a brackish desalination plant along the Hudson River. Inima USA is building the first major desalination plant in the northeast, which will treat brackish river water for Brockton, Massachusetts. Poseidon Resources wants to build the largest seawater desalination plant in the western hemisphere in California.

These plants plan to sell their desalted water to public systems. Unfortunately, this is a dangerous arrangement for a vital public good such as drinking water because private corporations often put their bottom line before the public interest.

First, private control of desalination facilities means that local governments that purchase the water lose control over the pricing and the quantity of water available. For example, Inima USA's new $60 million desalination plant commissioned by Brockton is actually owned by Inima, which is a division of another company, Spain-based OHL.[38] Regardless of whether the town receives any water, Brockton will pay a fixed fee of $3.2 million per year for the first three years, which will increase annually thereafter. On top of that, the town will pay a fee for the actual water, depending on how much it receives.[39] This arrangement will likely leave the town little control over the price of water.

Also, private control of water makes it difficult to ensure public safety. Public water systems mandate transparent, accountable management, while private companies consider management issues to be proprietary business information. Thus, private companies are less likely to publicize the health or environmental impacts of their plants. The difference between public and private entities conducting research on desalination can be seen clearly in comparing the proposal submitted by the Long Beach Water Department with that of Poseidon Resources, a private company. The LBWD thoroughly researched the energy and environmental impacts of its project and posted the results on its Web site, while Poseidon Resources, if it conducted such reviews, did not make them public.[40]

The costs of desalination are still "quite high when compared with the costs of alternatives in most locales." – The National Research Council

Ocean Desalination Is Dangerous to the Environment and Public Health

While numbers do a good job of illustrating the pure financial cost of desalination, they do not do justice to the full expense. Additional costs borne by the public include damage to the environment, danger to the public health and other external considerations.

Not surprisingly, these costs are often glossed over when proposals are made. According to the National Research Council report, external costs are rarely evaluated accurately when desalination projects are proposed and sometimes ignored completely.[41] But these costs can be significant.

Ocean desalination contributes to global warming

Every step of reverse osmosis, from the water intake to the high-pressure pumps, transport and waste disposal systems, requires large amounts of energy. In addition, the saltier the source water, the more energy required to remove the salt. Seawater is the most concentrated source water solution there is, which means that ocean desalination is the most energy intensive desalination process.

Based on cost estimates from the National Research Council report,[42] seawater desalination in California takes nine times as much energy as surface water treatment and 14 times as much energy as groundwater production.* Meanwhile, very few desalination plants use renewable energy sources. Surfrider Foundation and San Diego Coastkeeper estimated that a 53 million gallon-per-day desalination plant would cause nearly double the emissions of treating and reusing the same amount of water.[43] Ironically, these emissions contribute to global climate change, which will only quicken the droughts and water shortages that desalination is supposed to help us avoid.

*See methodology section for calculation.

Debunking Industry Hype: Ocean Desalination Will Provide Little Benefit

Industry sources tend to exaggerate the capacity, and thus the seeming promise, of ocean desalination. While media and marketing focus on seawater desalination, most plants in the United States neither use seawater as a source nor produce drinking water. According to the National Research Council report, the vast majority treat brackish water rather than seawater, and half of all existing plants serve only small-scale industrial purposes.[44]

Moreover, industry estimates inflate the promise of existing plants to produce water by including plants that do not actually produce water in their surveys. The Wangnick/GWI estimate of desalination in the United States, for example, includes planned plants that were never actually built, completed plants that never produced water, plants that no longer operate, and plants used only for testing. For example, the Wangnick/GWI survey included a large government-built plant in Yuma, Arizona, even though it only produced water during short test runs.[45]

Furthermore, many existing plants simply do not produce at their stated capacity, if they produce water at all. For example, in a survey of desalination facilities along the California coast, the five plants listed as serving a municipal use were labeled as "intermittent use," "decommissioned," "temporarily idle," "inactive" and "not known."[46] Meanwhile, a comprehensive survey prepared for the Texas Water Development Board in 2005 indicated that for three of the state's five largest desalination plants that produce drinking water, the average production was only half of the stated design capacity.[47] And these plants are using surface or groundwater, not seawater.[48] Although the Texas Water Development Board has been researching seawater desalination options for years, its first proposed seawater project is only 10% the size of a full scale plant and, as of December 2008, was still seeking funding approval.[49]

So although desalination plants have now been built in every state, this impressive statistic is tempered by a closer look at production capacity. Even with these inflated numbers, the National Research Council estimates that all 1,100 plants in the United States (including brackish plants and plants used only for industry) operating at their full capacity could produce a measly 0.4 percent of the country's water use.[50]

To see the futility of this technology, take a look at California, the state with the most major proposed ocean desalination plants. If all of the proposed plants functioned at their full capacity, they would increase the state's desalination ability 70 times over. Yet, the additional water would only cover 6 percent of the state's urban water use from 2000.[51] Keep in mind that this calculation was based only on urban water use, which means desalted water would provide an even smaller percentage of the state's total water use.

Food & Water Watch calculated that with this extra water, everyone in California could take one extra three-minute shower a day.* Meanwhile, if all financial, environmental and social impacts were factored in, this three-minute shower likely would be the most expensive shower most citizens have ever taken.

Debunking Industry Hype: Ocean Desalination Has a Poor Track Record

Many of the theoretical concerns associated with ocean desalination came true when Tampa Bay commissioned the first and only large-scale seawater desalination plant to come online for drinking water use in this country. In the 1990s, a series of poor management decisions overdrew Florida's groundwater systems, leaving Tampa Bay authorities fearful of water shortages. To address this risk, they decided to build North America's first and largest ocean desalination plant.

In 1999, the West Coast Regional Water Supply Authority, which later became Tampa Bay Water, chose S&W Water, LLC, a conglomerate of Poseidon Water Resources and Stone & Webster, to build the plant. Bankruptcies and contract transfers brought the operation online for tests a year behind schedule. Technical failures followed and the plant could not meet environmental standards. The company charged with construction of the plant declared bankruptcy.[52] The plant eventually reopened, several lawsuits and years later, but at a much higher cost of $158 million — nearly 44 percent more than promised.[53] Due to the failure of the private companies to uphold their end of the bargain, the Tampa Bay Water Authority, a public utility, now operates the plant.[54]

To this day, the plant has not produced water at its stated capacity and costs far more than planned — even without factoring in any social or environmental costs, which have yet to be quantified.

Despite the failures of the Tampa Bay project, fast-growing communities in northeast Florida are still considering the ocean as a source of drinking water. Some have even suggested outfitting an old oil tanker anchored offshore with desalination equipment — a project that would cost up to $200 million and create the first floating desalination factory to supply municipal water in the country.[55]

*See methodology section for calculation.

Ocean desalination damages marine life

Ocean desalination plants can wreak havoc on marine life and commercial fisheries. Many proposed coastal plants rely on power plants to pull in ocean water. These power plants use outdated "once-through cooling water intake structures" that cool the plants by pulling in large quantities of seawater. Desalination plants located next to these facilities take a portion of the outgoing water from these systems for their water supply.

The problem here is that these structures suck in a lot more than seawater — they also bring marine life that dies in the machinery. According to EPA, these intake structures kill at least 3.4 billion fish and other organisms annually. Larger organisms are trapped against the intake screens, and smaller ones, such as fish eggs and larvae, are drawn through the intake screens and destroyed in the cooling system. As a result, fishermen lose at least 165 million pounds of fish today and 717.1 million pounds of potential future catch. This is equivalent to a $212.5 million economic loss to anglers and commercial fishermen.[56]

California's power plant intake structures alone are responsible for the destruction of at least 312.9 million organisms each year, resulting in the lost catch of at least 28.9 million pounds of fish and 43.6 million pounds of potential future catch. This amounts to a $13.6 million loss to fishermen.[57]

Ocean desalination pollutes

A large amount of the water that exits desalination plants is concentrated waste rather than drinking water. This is because reverse osmosis cannot separate salt from all the water that enters the plant. Depending on the equipment, reverse osmosis desalination membranes can reclaim 60 percent to 85 percent of brackish water and only 35 percent to 60 percent of ocean water.[58] For example, the proposed plant in Carlsbad, California, will desalinate only half of the water that enters the plant.[59]

Ocean Desalination Moves East?

As growing populations strain existing water resources, even the water rich east coast is considering ocean desalination. Already, mismanagement of groundwater resources brought brackish groundwater desalination to the southeast. Starting in the 1970s, many resort towns along the east coast began constructing plants. As increased tourism and new economic developments drew more water from the ground, saltwater from the ocean was gradually creeping into the underground aquifers to replace the fresh water that was removed. Eventually, many existing wells became too salty to drink. From Mount Pleasant, South Carolina, to North Carolina's Outer Banks to Newport News in Virginia, resort towns built groundwater desalination plants to keep up with demand.[60] This trend crept all the way up the Atlantic Coast to Cape May, New Jersey, which began installing the northern most desalination plant in 1998 after community wells buckled under the tripled demand for water during the summer tourist season.[61] In the last couple years, new projects have been proposed in Savannah, Georgia[62], and Hilton Head Island, South Carolina.[63]

Meanwhile, despite receiving 44 inches of rainfall a year, population growth and economic development have strained New England's water resources.[64] Some New England communities are starting to look at desalination as an option. The town of Brockton, Massachusetts, commissioned a private company to build a desalination plant to supply a fifth of its drinking water from desalted Taunton River water.[65] Meanwhile, another private company, United Water New York, submitted plans to construct a private plant on the Hudson River.[66]

Other towns in the region, such as Seabrook, New Hampshire, and Hull, Massachusetts, have considered desalination options,[67] although few projects are actually slated for construction in the region. One plant, in Swansea, Rhode Island, is scheduled to be the first municipality to own and operate a large-scale desalination plant in the East.[68] By the end of 2008, the town had rejected three construction bids that were too expensive, and it is still hoping to bring down the price and complete the project by the end of 2009.[69]

Although most projects and proposed projects on the East Coast involve brackish ground or river water, ocean desalination proposals may become more prevalent if current trends continue.

Poseidon Resources, Inc.

After masterminding the failed Tampa Bay venture, Poseidon Resources, Inc. is trying its hand at ocean desalination a second time. Its proposed plant in Carlsbad, California, would be the largest ocean desalination plant in the western hemisphere — twice as large as the Tampa Bay plant.

Poseidon Resources has been trying to get its plan approved for the last 10 years. The company has been relentless in its marketing, however, and is now promising that its plant will be carbon neutral. This claim is misleading. Poseidon's calculation assumes that the amount of energy used by the desalination plant will be mostly offset by the energy that would have been required to import the same amount of water. However, there is insufficient evidence that desalinated water will actually replace imported water in the California water supply.[70]

Unfortunately, the Coastal Commission, the governmental body charged with protecting the state's coast, approved a permit for the plant in August 2008.[71] This sets a dangerous precedent. If the plant is built without proper consideration for social and environmental impacts, it may become the first in a long line of polluting, damaging plants along the California coast.

Two conservation groups have filed a lawsuit against the San Diego Regional Water Quality Control Board, charging that the board did not adequately study how the plant would harm marine life.[72]

In December 2008, the San Diego County Water Authority requested $175 million from the federal government as part of its economic stimulus package to subsidize the $300 million project, which it would give to Poseidon in exchange for the company reducing its rates for the agencies buying the water.[73] The company has yet to secure financing for the movement of the water from the project, despite the fact that it is scheduled for construction in 2009.

The federal taxpayer dollars would enable the company to realize a profit faster, while ratepayers will still be paying more than market price for desalinated water.[74]

The significant portion of remaining water contains the salts and other dissolved solids from source water, but at dangerous concentrations two to 10 times higher than the original water.[75] In addition, it contains some or all of the scale inhibitors, acids, coagulants, ferric chloride, flocculents, cationic polymer, chlorines, bisulfites and hydrogen peroxides used to treat the feed water and clean the membranes,[76] along with heavy metals from contact with plant machinery.[77]

There is simply nowhere to put this liquid waste that does not pose a danger to our water systems. Most coastal plants dump their waste directly into the ocean, increasing the salinity and temperature and decreasing the water quality in the surrounding ecosystem.[78]

Proponents argue that by dumping the toxic chemicals into a very large body of water, they will spread out and become less dangerous. While this may be true of some substances, such as salt, others, such as heavy metals, remain just as dangerous after dilution.[79]

Further, when concentrated waste is dumped directly into the ocean, it may have localized impacts, such as killing marine organisms or displacing them from their natural habitat. This raises particular problems when the affected marine life communities are rare or of special interest.[80]

The second most common disposal method for desalinated waste is not appropriate for seawater desalination. This method involves transporting the wastes to a nearby sewage treatment plant. However, seawater waste is more concentrated than waste from brackish plants. It can overload the treatment system and prohibit reuse of the wastewater because standard treatments cannot remove contaminants from the seawater waste.[81]

Other less common disposal methods include injecting waste into wells, leaving it in open ponds to evaporate or spraying it on crops — all of which run the risk of having it leak into clean groundwater. Only one method — called Zero Liquid Discharge — does not have a liquid byproduct, but it is so expensive and energy intensive that it is not a realistic option for any existing plant.[82]

Ocean Desalination Threatens Coastal Resources

In addition to coastal pollution, desalination can contribute to unwise coastal over-development. One drawback to this is that industrial plants along the coast can impair views and interfere with the recreational use of seawater.

Another is that building water-producing facilities in a region that otherwise wouldn't have sufficient water encourages unsound coastal management.[83] In Huntington Beach, California, for example, a proposed desalination project failed to identify any current users for its water. Indeed, the city's Urban Water Management Plan has not identified ocean desalination as a necessary component of expected growth.[84]

Ocean Desalination Threatens Public Health

Environmental damage is not the only danger from ocean desalination. Desalted water also puts the drinking water supply at risk because both seawater and brackish water can contain chemicals that freshwater does not. These contaminants include chemicals such as endocrine disruptors, pharmaceuticals, personal care products and toxins from marine algae.[85] Some of these contaminants may not be adequately removed in the reverse osmosis process.

Boron is a chemical of particular concern because much higher levels are found in seawater than freshwater. However, membranes can remove only between 50 and 70 percent of this element. The rest is concentrated in the product water, which enters the drinking water system.[86] While it is possible to remove more boron with a second process, existing plants don't because it is too costly.[87]

This is a major problem for the drinking water system because boron is known to cause reproductive and developmental problems in experimental animals and irritation of the human digestive tract.[88] Moreover, the world's largest ocean desalination plant in Ashkelon, Israel found that the boron in the desalted water acted as an herbicide when applied to crops.[89]

Current drinking water regulations do not protect the public from boron. Recently, EPA made the preliminary determination that it would not regulate the element as a primary contaminant under the Safe Drinking Water Act because of its low occurrence in traditional sources of drinking water.[90] However, the studies that EPA used to make this decision did not take into account the hike in boron levels that would occur if desalted water was to be added to the system.

Ocean Desalination Promotes Social and Environmental Injustice

Unfortunately, the costs of desalination get passed down to the consumer. For example, the California American Water Company demanded an up-front rate increase to construct its proposed plant in Monterey, California, before it ever produced a drop of water.[91] Across the country, in Brockton, Massachusetts, ratepayers expected to see an estimated 30 percent hike in their water rates once the city started buying desalinated river water.[92] In 2008, the city council voted for a 60 percent increase in rates before the plant even came online.[93]

Such price hikes are not just a problem for individuals, but also for society. Water is a basic human need that must be available to all citizens, and most communities cannot afford to pay exorbitant prices for the desalted water. This means that ocean desalination contributes to social injustice, because the costs of rate hikes fall disproportionately on low-income communities.[94]

To add insult to injury, the people in these communities tend to be the same people who would be most likely to experience the negative effects from the plants. In California, for example, most proposed desalination plants would serve affluent communities in Marin County, the Monterey area, Cambria, southern Orange County and northern San Diego County.[95] However, most of the proposed plants will be built in industrial areas, which tend to house low-income communities.[96] These populations will experience the increased air pollution, noise and traffic that come from the plants. Meanwhile, low-income coastal communities that rely on subsistence fishing may be exposed to high levels of toxins in fish that are exposed to desalination waste products.[97]

So What Should We Do Instead? Alternatives Abound

With all costs considered, ocean desalination is a risky water supply option. This means that while policymakers are dealing with ocean desalination proposals, they are distracted from evaluating and implementing better options. In fact, emphasis on ocean desalination ignores the fact that the water shortages in our country are not due to a lack of natural water resources, but rather to shortsighted water policy that focuses on finding new water resources instead of managing existing resources wisely.

Cooling to Cooling Intakes?

The U.S. Environmental Protection Agency has recommended that existing power companies significantly reduce the destruction of sea life from cooling water intake structures. A federal court recently ruled that even these regulations were insufficient. The U.S. Supreme Court is reviewing that decision.[98]

If the courts allow the sea life destruction from power plants to continue, desalination plants may keep relying on these structures for pulling in water. Locating desalination operations next to power plants may even cause some of the power plants to run for longer periods of time, contributing to global warming and air pollution. Thus, these desalination plants may even give new life to power plants that were once thought to be headed for retirement.

But even if the courts decide that power plants need to reduce their damage, desalination might still continue to contribute to the destruction of marine life.

As power plants begin to shift away from once-through cooling intakes, the structures might be sold or given to desalination plants for continued use, virtually free of regulation in some states.

Although many plants seek to use these out-dated structures, there are other options, called "subsurface intakes." Pipes can be constructed under the ocean floor, so that the intake area is covered with sediment. When the pipes suck in water, the sand serves as a barrier to keep out unwanted marine life.[99] These barriers not only reduce the destruction of sea life, they also have demonstrated energy savings.

State and federal laws are needed to ensure that coastal environments are protected from the water intakes from all desalination plants.

Brackish Desalination

Although brackish desalination is less energy intensive than ocean desalination and does not impact coastal environments, it poses its own set of challenges.

Inland plants that use brackish sources typically draw their water from the ground using wells. Some plants that use seawater also get their water from wells, drilling into the ground near the ocean to take advantage of the lower water table.

Unfortunately, this can pollute groundwater and concentrate can leak from pipes into the ground.[100] Even worse, drawing water from underground aquifers can change the natural flow of the aquifer and actually cause increased salinity over time.[101] Overdrawing groundwater sources can cause shifts in the ground level itself, and even earthquakes.[102] So plants that draw salty water out of the ground to desalinate it can actually cause irreversible damage to entire groundwater systems if proper precautions are not taken.

Moreover, although brackish desalination is usually cheaper than ocean desalination because it requires less energy, this is not always the case. Inland plants cannot dump their brine directly into a nearby ocean — they must transport their waste to other water bodies or treatment plants. This expensive process can rival the extra energy costs of seawater desalination.[103]

Communities that resort to brackish water desalination should not only address these problems, they should address the fundamental question when considering ocean desalination plants: Is it really needed? Or will conservation supply the same water needs without the risks?

Further, our country loses 6 billion gallons of water per day due to problems such as leaking pipes. Utilities cannot account for this water because many have not implemented comprehensive leak monitoring programs.[104] Meanwhile, all of the desalination plants in the United States today operating at their full capacity[105] could only produce a quarter of that unaccounted for water.*

Numerous academic studies show that management alternatives and efficiency programs offer great potential for alleviating water supply problems at a much lower cost and without the dangers associated with large scale reverse osmosis plants. According to the National Research Council report on desalination, simply redistributing water can be much cheaper than desalination and more efficient.[106] The proposed Massachusetts Conservation Standards agree. They state that "finding new water by investing in efficiency and demand management is almost always more cost-effective than developing a new source."[107] Likewise, a World Bank official told the World Wildlife Fund that "saving water rather than the development of new sources is often the best 'next' source of water both from an economic and from an environmental point of view."[108]

Peter Gleick and Gary Wolff of the Pacific Institute, a non-profit research group, refer to such methods as the "soft path" for water, which "strives to improve the overall productivity of water use rather than seek endless sources of new supply."[109] These techniques include focusing on water needs rather than supplies, decentralizing water systems, including community groups in decision making and maintaining ecosystem health.

The Pacific Institute has conducted many studies showing that numerous areas considering desalination could use conservation programs to provide their water needs instead. California could save a full third of its current water use, 85 percent of which could be saved at costs lower than new sources of water.[110] Similarly, a thorough review of Atlanta's water conservation plan concluded that the program left "significant untapped potential," while still providing for population growth and economic development.[111] Meanwhile, the EPA provides many case studies of successful efficiency programs in many states considering desalination, including Massachusetts and California.[112]

In fact, a few policymakers who have attempted to implement ocean desalination have found that, after all the expense, other options were more appropriate. For example, in 1991, Santa Barbara and the Montecito and Goleta Water Districts constructed a $34 million plant during a drought. However, the drought ended before it came online, and the city found that conservation measures implemented during

High-Tech Problems

Desalination is not the only dangerous big water supply technology that does more harm than good to our water resources. More than 45,000 large dams built around the world trap organic materials, evict people from their homes, reduce biodiversity, disrupt natural river flows and contribute to global climate change. The many large dams around the world largely account for why so many of the world's major rivers no longer meet the sea — only 21 of 177 of the world's longest rivers now reach the ocean.[113]

Meanwhile, water diversions through canals and pipelines also drain watersheds, destroy existing ecosystems and deplete local water resources. The Aral Sea, which used to be the world's fourth largest lake, has lost 80 percent of its water due to diversions, while Lake Chad, once the sixth largest lake in the world, is nearly dry.[114]

Proponents of ocean desalination often paint it as a better option when compared to these alternatives. But this is a faulty comparison. Again, decision makers should be asking whether any of these technological quick fixes are better than comprehensive conservation programs.

*See methodology section for calculation.

the drought were successful in reducing demand.[115] The plant is no longer in operation.[116]

In Tampa Bay, where water authorities created the largest ocean desalination plant in the country to avoid shortages, other options were actually more effective. While the desalination plant experienced technical and bureaucratic failures, Tampa Bay Water built a new reservoir and treatment plant, and implemented conservation programs. In this time, groundwater pumping decreased from 192 million to 121 million gallons per day, despite increased population.[117] This meant savings of 71 million gallons a day — almost three times as much as the 25 million gallons a day that the desalination plant was supposed to produce.

Conclusion

Ocean desalination is not a safe or affordable drinking water option. Water from these plants costs far more than other water supply options, which means rate hikes that fall disproportionately on the very citizens who can least afford them. Meanwhile, the associated water pollution, chemical contaminants, marine life destruction, global warming and privatization could cause irreparable damage to our remaining clean water resources and public drinking water systems.

While private speculators are trying to push desalination plants across the country, local citizens have made some gains in persuading decision-makers to abandon or reshape proposals to match local priorities. For example, the City of Los Angeles's 20-year water supply plan now relies on water reuse and conservation and does not include ocean desalination. In the Monterey Bay area of California, a stakeholder process put ocean desalination at the bottom of a list of priorities for water supply. Local communities have formed groups like the Residents for Responsible Desal in Huntington Beach, California and the statewide Desal Response Group to collect information on alternatives and weigh in on the regulatory process.

Despite the efforts of corporations like Poseidon which are lobbying hard and spending millions of dollars to get their desalination projects approved, citizens are slowly working to convince decision-makers that ocean desalination is an unwise choice. A lot of work remains, however.

No community should consider desalination until all conservation options are fully evaluated and implemented. Meanwhile, federal, state and local governments should implement aggressive water conservation policies. It is imperative that the government takes this step, because private industry will not. For the companies that sell water, conservation is simply not profitable because it reduces revenues. In terms of the public good, however, such programs are extremely profitable because they protect our nation's public water systems and thereby ensure future access to clean water.

Recommendations:

- Citizens should encourage state, local and federal policymakers to abandon ocean desalination as a supply option and should instead implement comprehensive conservation measures. If ocean desalination is the best option, the plants should be publicly owned.

- Federal and state governments should not be subsidizing this technology. As a "growth sector," private companies have more than enough means to support their own research and development.

- New federal and state laws are needed to protect consumers, public health and coastal environments from ocean desalination.

Methodology for Calculations

1. ...RO membranes that have holes 0.0001 to 0.001 microns wide — a distance 70,000 times smaller than a human hair.
Diameter of a human hair: 70 microns
http://www.airfiltrationsolutions.com/FAQ.htm#Micron
70/.001 = 70,000

2. Food & Water Watch calculated that with this extra water, everyone in California could take one extra three-minute shower a day.
2006 Population Estimate of California: 36,457,549
http://quickfacts.census.gov/qfd/states/06000.html
Increase in capacity: 450 million gallons per day
Gallons used per shower minute= ~ 4 (low flow 2-4 gallons/minute, standard 7-10)
http://www.wssc.dst.md.us/service/waterusagechart.cfm
Extra gallons per person = Increase in capacity / Population
= 450,000,000 / 36,457,549 = 12.34 ~ 12 extra gallons / person
Extra minutes in the shower = Extra gallons / Gallons used per shower minute
= 12 / 4 = 3 extra shower minutes

3. Based on cost estimates from the National Research Council report, seawater desalination in California takes nine times as much energy as surface water treatment and 14 times as much energy as groundwater production.

Desal energy cost estimates:

Desal / Surface water treatment = 3.4 / 0.36 = 9.44 ~ 9 times the energy

Desal / Groundwater pumping = 3.4 / 0.24 = 14.17 ~ 14 times the energy

4. Meanwhile, all of the desalination plants in the United States today operating at their full capacity could only produce a quarter of that unaccounted for water.
CS Monitor: 6,000,000,000 gallons/day unaccounted for
NRC Desal plant production: 1,500,000,000 gallons/day
1,500,000,000 / 6,000,000,000 = 0.25 Desal gallons produced for every one unaccounted for

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