Fresh Solutions

Supplementary Materials

Desalination

Global water use has tripled in the last 50 years and demands for water are increasing due to population growth and increased demands from agriculture, industry, and households.

Desalination of salt water is a way to generate freshwater in places with inadequate supplies and is increasingly used to meet demands for water, especially in drier climates. Desalination removes salt from seawater resulting in drinkable water and salt residue. The left over salt is typically discarded and diluted before being released back into the sea. Water can be desalinized either by heating it under extremely hot temperatures (called distillation), or by forcing water through a filter under a high amount of pressure (called reverse osmosis).

The desalination process requires a lot of energy, which emits greenhouse gases into the atmosphere if that energy comes from fossil fuels. In California, it actually takes less energy to transport water to San Diego from the mountains of Northern California than it does to desalinate water in San Diego itself![1] In addition, desalination plants are expensive to operate and can cost hundreds of millions of dollars to build.

Desalination technology has improved greatly in the past 20 years and the costs are than one-fifth what they were in the 1990's. This is in large part due to improved reverse osmosis technology that has significantly reduced the energy needed to desalinate a gallon of water.[2]

However, people may perceive desalination as easier than saving water or changing habits and lifestyles. In California for example, a study by the Pacific Institute found that smarter water management and water recycling could save enough water for 125 desal plants![3]

The bright side is that earth has plentiful salt water! Desalination can provide a reliable source of water to dry areas and in some places it is the only way to provide adequate freshwater. Freshwater from desalination doesn't compete with surface water supplies available for other animals and ecosystems. However, disposal of the salt residue left over from desalination can be troublesome and can pollute marine ecosystems.[4]

To learn about other solutions to global water issues, read more at **Fresh Solutions**.

[1] Little, Amanda (July 22, 2015)
[2] World Business Council for Sustainable Development (2009)
[3] The Pacific Institute and the Natural Resources Defense Council (2014)
[4] KQED Science (March 30, 2015)

Weighing the Benefits and Drawbacks of Desalination

For a complex problem, we need to evaluate how a solution fares across multiple dimensions:	Benefits	Drawbacks
Environmental Factors		
Social & Cultural Factors		
Economic Factors		

Fresh Solutions

Supplementary Materials

Weighing the Benefits and Drawbacks of Desalination

For a complex problem, we need to evaluate how a solution fares across multiple dimensions:	Benefits	Drawbacks
Environmental Factors	• The earth has plenty of salt water. • By making our own freshwater, we save lakes and rivers for other animals and plants.	• What do we do with all the salt that ends up as a waste product? • Uses a lot of energy, so we are using fossil fuels and releasing carbon into the atmosphere. • Sea life may be harmed near intake/output pipes.
Social & Cultural Factors	• Reliable supply of water for places that are always dry, like Israel. • May be easier to make more freshwater than convince people to change behavior.[3] • Could solve our freshwater needs.	• May make people less likely to reduce their water use • Large building and pipes might be an eyesore (*Not in **my** backyard!*)
Economic Factors	• Technology is getting better and better, so costs are going down.[1] • Provides jobs for people in construction, and then to run the plant.	• Expensive to build. • Expensive to operate each year—cost of energy to run the plant. • Water bills for people might go up. • Some plants will close if they don't have "business" during wet years.

Additional resources

KQED: Why isn't desalination the answer to all California's water problems?
Public Radio International: We're running out of water. Is desalination the answer?
LA Times Editorial Board: In Huntington Beach, a desalination plant that makes sense
Teacher tip: *Discuss with your students how an editorial or "op-ed" is different than other journalism found in the newspaper.*

Fresh Solutions

Supplementary Materials

Drip Irrigation

Globally 70 percent of freshwater is used for agriculture, to grow the food we eat and the cotton we wear. But the amount of water it takes to grow crops depends on the different practices used on farms.

A lot of farmers use sprinklers to irrigate crops, and this kind of irrigation wastes a great deal of water. If you've ever watered your garden or yard with a sprinkler on a sunny day, you can see water evaporate above the sprinkler—that's water that won't make it to the soil where it's needed.

There are different ways to irrigate crops that can save water. 'Drip irrigation' delivers small amounts of water directly to the soil where the plant is grown and is more efficient than conventional sprinklers. A drip irrigation system can be a series of water hoses with small holes in them that deliver small amounts of water where it is needed. Drip irrigation minimizes water loss from evaporation and runoff, and uses 20 to 50 percent less water than conventional sprinklers.[1]

Drip irrigation systems can cost a lot of money upfront, but also have the potential to increase crop yields[2], which benefits farmers in the long run. Some farmers have been using drip irrigation technology with sensors that tell the farmer where there are dry spots. Farmers can use these sensors to water fields precisely where water is needed.

To learn about other solutions to global water issues, read more at **Fresh Solutions**.

[1] U.S. EPA Water Sense (Accessed November 11, 2015)
[2] Fishman, Charles (August, 2015)

Weighing the Benefits and Drawbacks of Drip Irrigation

For a complex problem, we need to evaluate how a solution fares across multiple dimensions:	Benefits	Drawbacks
Environmental Factors		
Social & Cultural Factors		
Economic Factors		

Fresh Solutions

Supplementary Materials

Weighing the Benefits and Drawbacks of Drip Irrigation

For a complex problem, we need to evaluate how a solution fares across multiple dimensions:	Benefits	Drawbacks
Environmental Factors	• Reduces groundwater use for agriculture. • Leaves more surface water for other animals and ecosystems.	• Irrigation uses a lot of groundwater, which takes many years to replenish.
Social & Cultural Factors	• Drip irrigation with remote sensors can save farmers time by telling them precisely where water is needed.	
Economic Factors	• Reduce the water costs of irrigation. • Better crop yields means more income for farmers.	• Large upfront cost to drip irrigation infrastructure.

Additional Resources

Check out how much water it takes to produce different kinds of food at Waterfootprint.org
U.S. Environmental Protection Agency Water Sense: Water-Saving Technologies
New York Times Opinion: How California Is Winning the Drought
ENSIA: How to grow more food with less water

Fresh Solutions

Supplementary Materials

Groundwater Recharge

There's more water underground than there is in all of the above ground reservoirs and lakes, including the great lakes.[1] The water in groundwater aquifers comes from the slow seeping of rain and melted snow water down through cracks and pore spaces in rock and sand. It can take many years for an aquifer to build up a reserve of water. In some cases, water has been stored in underground aquifers for hundreds of thousands of years!

Groundwater reserves are being depleted rapidly in many places around the world, especially places that are experiencing drought, such as the state of California. One study estimates 20 percent of the world's aquifers are being over pumped, meaning water is being pumped out of them for agriculture and other uses faster than rain and snow melt can replenish this water.[2]

The natural replenishment of groundwater by rain and snow melt can be disrupted by cement roads, buildings, and parking lots—'impermeable surfaces'—that prevent water from seeping down into the ground. Recently, people have been taking advantage of the great storage capacity of aquifers by helping to put water back into them. This is called artificial groundwater recharge.

A common method for getting more water back underground uses shallow man-made ponds to collect water, called recharge ponds, which allow water to seep through soil and rocks to underground aquifers. These recharge ponds can also capture rain during big storms. A more energy intensive way to put water underground is called an injection well, which uses high-pressure pumps to push water back underground.

Storing water underground can reduce water losses through evaporation and can also replenish water needs for ecosystems and rivers that depend on groundwater. Groundwater recharge has also been found to be cheaper than expanding surface reservoirs by building dams.[3] Sometimes depleted coastal aquifers can be infiltrated with salt water. Since salt water is not good for either drinking or irrigating crops, recharging the aquifer is a way to prevent this from happening.

To learn about other solutions to global water issues, read more at **Fresh Solutions**.

[1] USGS (2015)
[2] Mascarelli, A. (2012)
[3] Stanford University: Water in the West (December, 2014)

Weighing the Benefits and Drawbacks of Groundwater Recharge

For a complex problem, we need to evaluate how a solution fares across multiple dimensions:	Benefits	Drawbacks
Environmental Factors		
Social & Cultural Factors		
Economic Factors		

Fresh Solutions

Supplementary Materials

Weighing the Benefits and Drawbacks of Groundwater Recharge

For a complex problem, we need to evaluate how a solution fares across multiple dimensions:	Benefits	Drawbacks
Environmental Factors	• Less water loss than surface storage. • Recharge prevents salt water intrusion. • Replenishes water needs for ground-water dependent ecosystems and rivers. • Recharge ponds can capture water from heavy storms.	• Energy is required to extract water from aquifers for human use after the water has been replenished.
Social & Cultural Factors	• Groundwater can be distributed across the state. • Recharge puts water back into aquifers where others can use it.	
Economic Factors	• Less expensive than desalination. • Cheaper than expanding surface dams and reservoirs.	• Upfront cost to build recharge ponds.

Additional Resources

Stanford University: Water in the West
UC Davis: Map identifies farmland with greatest potential for groundwater recharge
ENSIA: Groundwater wake-up

Fresh Solutions

Supplementary Materials

Water Recycling

Re-using and recycling water has huge potential to alleviate our water needs, especially in urban areas. Water used in households and businesses is typically treated and disposed of (e.g., pumped out to sea) after just one use. By re-using water, we can use it for multiple purposes before it is discarded. Water recycling involves filtration and re-use, instead of just disposing it after one use. Recycled water is also called 'reclaimed' water.

Greywater is water that has been used in bathtubs, washing machines, showers, and bathroom sinks. Greywater can be re-claimed and used in gardens and to flush toilets. It's estimated that 60 to 65 percent of the water used in homes can be re-used![1] Water re-use can be as simple as saving water used for washing dishes for plants in the garden.

Irrigating lawns and parks is a common use for reclaimed water. Reclaimed water can also be used on farms. In Delaware, reclaimed water has been used for irrigating crops since the 1970's. A 2007 study estimated that over 20 million hectares—about the size of Nebraska—of farmland are irrigated with reclaimed water, and this is expected to increase with greater demands for food.[2]

Water that has been used to flush toilets (referred to as black water) can be recycled by filtering and sanitizing the water on site, using a method called reverse osmosis. The average American uses 24 gallons of water a day just for flushing toilets. If water recycling systems were implemented for every toilet, this could save 5.8 billion gallons of water per day![3]

In Orange County, California, wastewater is filtered and then put back into underground aquifers used for drinking water. Orange County is one of the few places where residents drink recycled wastewater.[4]

Unfortunately, many people may reject drinking water that has been recycled from toilets. Recycling black water would require potentially costly changes to indoor plumbing for filtration. But when compared to desalination, re-using and recycling water is typically cheaper and less energy intensive.[5]

To learn about other solutions to global water issues, read more at **Fresh Solutions**.

[1] Lamb, Robert "How Gray Water Reclamation Works" How Stuff Works, accessed October 12, 2015
[2] Hamilton, Andrew J. et al (2007)
[3] Cho, Renee (April, 2011)
[4] Judd, J.W. (April 2015)
[5] Monks, Kieron (May 1, 2014)

Weighing the Benefits and Drawbacks of Recycling Waste Water

For a complex problem, we need to evaluate how a solution fares across multiple dimensions:	Benefits	Drawbacks
Environmental Factors		
Social & Cultural Factors		
Economic Factors		

Fresh Solutions

Supplementary Materials

Weighing the Benefits and Drawbacks of Recycling Waste Water

For a complex problem, we need to evaluate how a solution fares across multiple dimensions:	Benefits	Drawbacks
Environmental Factors	• Water recycling uses less energy than desalination.4 • Alleviates pressure on rivers, lakes, and streams that are essential to other animals and ecosystems. • Could reduce withdrawals from aquifers.	• Re-using and recycling water is more energy intensive than reducing overall water use.
Social & Cultural Factors	• Re-using household water could make people more aware of their total water use.	• People may reject recycled water, especially recycled black water. This is called the "yuck factor."
Economic Factors	• Cheaper alternative than desalination. • Could reduce the cost of withdrawing water from aquifers.	• Upfront costs of changing a building's plumbing infrastructure. • More costly than reducing overall water use.

Additional Resources

ENSIA: Reuse: The next wave of water conservation?
Pacific Standard: A Rundown on Recycled Wastewater
How Stuff Works: How Gray Water Reclamation Works
Pew Charitable Trusts: States, Cities Get Creative About Recycling Water