

# Water

18 April 2007  
39th class meeting

**READINGS**  
Wednesday 18 April:  
Water:  
Postel 2001; EPA website; 3Gorges:  
<http://news.bbc.co.uk/2/hi/asia-pacific/500092.stm>  
Friday 20 April: Earth Day or Video



Women in the Philippines vie for a place in Miss Earth - an international beauty pageant aiming to raise awareness of environmental issues.

Lab 18/20 April: meet at van s-side BSE  
Thank Robichaux, Mangin, Delgado

Environmental Biology (ECOL 206)  
University of Arizona, spring 2007

Kevin Bonine, Ph.D.  
Anna Tyler, Graduate TA

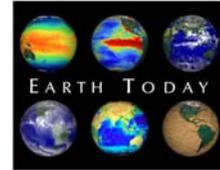
[http://eebweb.arizona.edu/courses/Ecol206/206\\_Page2007.html](http://eebweb.arizona.edu/courses/Ecol206/206_Page2007.html)

1

- Tuna
- Dolphin-set nets
- Trawling
- Bycatch
- Vaquita
- Shrimp/Fish Farms
- Community Solutions
- Shifting Baselines
- Acidification
- Mercury

## Conservation of the marine environment

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# WATER



Elephants spray water on motorcyclists during a festival to mark Songkran, or Thai New Year, which falls on 13 April.



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## WATER (Ch9)

- Organisms made of water
- Hydrogen Bonds  
Surface Tension
- Broad temp range as liquid
- High Specific Heat
- Energy of phase changes
- Universal Solvent
- Expands when freezes (less dense)



71% planet surface  
(97.4% ocean)  
2.6% fresh  
-ice caps and glaciers (1.98%)  
-0.014% accessible  
lakes, soil, atmosphere  
biota, rivers

100 liters vs. 2.5 teaspoons (14ml)

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## Reservoirs of Water on Earth

Reservoir	Volume (10 <sup>6</sup> km <sup>3</sup> )	Percent of Total	Residence T
Oceans	1350	97.3	10 <sup>3</sup> -10 <sup>4</sup> yr
Glaciers	29	2.1	10 <sup>1</sup> -10 <sup>3</sup> yr
Aquifers	8	0.6	2 wks-10 <sup>4</sup> yr
Lakes	0.1	0.01	10 yr
Soil Moisture	0.1	0.01	52 days
Atmosphere	0.013	0.001	10 days
Rivers	0.002	0.0002	2 wks
Biosphere	0.001	0.0001	6 days

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## Aquatic and Marine Environments

### A. Salinity

### B. Layers:

1. Temperature
2. Sunlight
3. Dissolved O<sub>2</sub>
4. Nutrients
  - carbon
  - nitrogen (nitrate)
  - phosphorus (phosphate)



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Marine Environments

71% earth's surface is ocean

coastal vs. open sea

10% area, 90% species  
high NPP

- nutrients
- sunlight

1. Estuaries
2. Coastal Wetlands
  - mangroves
  - salt marshes
3. Coral Reefs



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- Role of sunlight
- Not very productive per unit area
- Lots total NPP

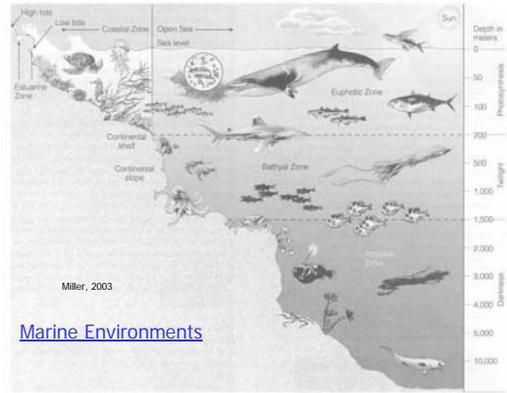


Figure 3-14 Major life zones in an ocean. (Actual depths of zones may vary)

Marine Environments

Coastal Pollution

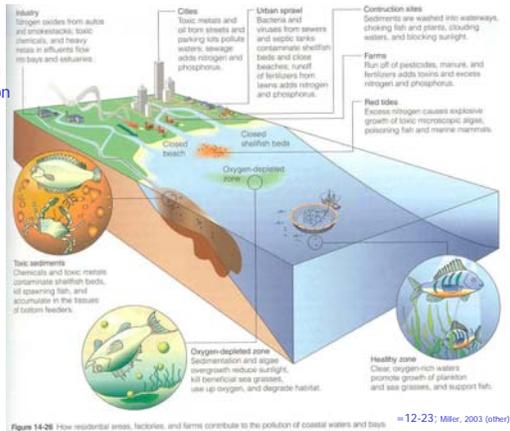


Figure 14-28 How residential areas, factories, and farms contribute to the pollution of coastal waters and bays. = 12-23; Miller, 2003 (other)

<http://www.mindfully.org/PlasticOcean/Moore-Trashed-PacificNov03.htm>



Bottle caps and other plastic objects are visible inside the decomposed carcass of this Laysan albatross on Kure Atoll, which lies in a remote and virtually uninhabited region of the North Pacific. The bird probably mistook the plastics for food and ingested them while foraging for prey.

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The Algalita Marine Research Foundation's investigation of plastic in the North Pacific Central Gyre of the Pacific Ocean showed that the mass of plastic pieces was six times greater than zooplankton floating on the water's surface. This study is one of many that demonstrate that our oceans have become the virtual garbage can for the developed and developing world.(1)

(1) C.J. Moore, S.L. Moore, M.K. Leecaster, and S.B. Weisberg. A Comparison of Plastic and Plankton in the North Pacific Central Gyre, Marine Pollution Bulletin, 13 February 2004.



Manatee flipper and monofilament



Whiting and condom

The trash was found in a patch of ocean called the North Pacific Gyre where the currents can trap floating debris for years.

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Chesapeake Bay

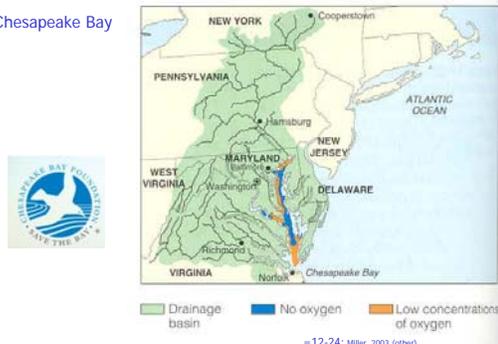


Figure 14-29 Chesapeake Bay, the largest estuary in the United States, is severely degraded as a result of water pollution from point and nonpoint sources in six states and from deposition of air pollutants.

[http://www.cbf.org/site/PageServer?pagename=cbf\\_homepage](http://www.cbf.org/site/PageServer?pagename=cbf_homepage)

Oxygen Depletion  
Gulf of Mexico

'Dead Zone'



Figure 14-28 A large zone of oxygen-depleted water forms for half of the year in the Gulf of Mexico as a result of oxygen-depleting algal blooms. It is created by huge inputs of nitrate (NO<sub>3</sub><sup>-</sup>) and phosphate (PO<sub>4</sub><sup>3-</sup>) plant nutrients from the massive Mississippi River Basin. Miller, 2003 (other)

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Oxygen Depletion

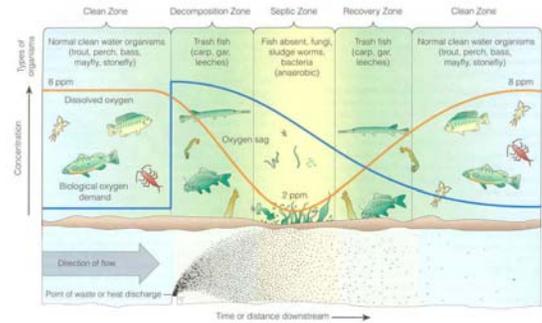


Figure 14-21 Dilution and decay of degradable, oxygen-demanding wastes and heat, showing the oxygen sag curve (orange) and the curve of oxygen demand (blue). Depending on flow rates and the amount of pollutants, streams recover from oxygen-demanding wastes and heat if they are given enough time and are not overloaded. Miller, 2003 (other)

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Marine  
Ecosystem  
Services

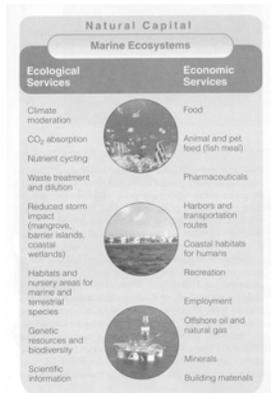


Figure 3-15 Natural capital: major ecological and economic services provided by marine systems.

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Marine  
Ecosystem  
Degradation

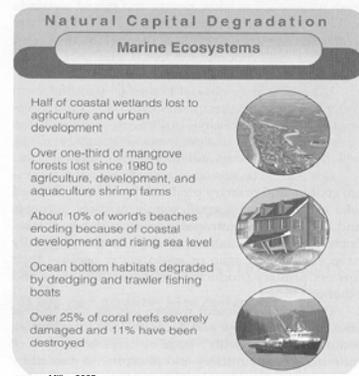


Figure 3-17 Natural capital degradation: major human impacts on the world's marine systems.

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*Cyprinodon macularius*

Desert Pupfish

Family Cyprinodontidae



-1-1/4 inches long  
max. age of three years

-females are gray and drab  
males are bluish, turning bright blue during spring breeding season.

-feed on insect larvae and other organic matter from pond bottom.

-prefer shallow pond depths, about 12 to 18 inches deep.

Quitobaquito pupfish (Endangered since 1986)

This tiny fish was once part of a widespread population, the range of which included the Colorado, Gila, San Pedro, Salt and Santa Cruz rivers and their tributaries in Arizona and California. The ancestors of the Quitobaquito and Sonoyta river pupfish are believed to have been cut off from their relatives in the Colorado River drainage about one million years ago.

The warm, slightly brackish water at Quitobaquito is ideal habitat for pupfish. Pupfish can tolerate salinity levels ranging from normal tap water to water three times saltier than the ocean. Therefore, they are well suited to desert environments where high evaporation rates create water with high salinity levels.

Although the water temperature at the spring is a constant 74°F, the water temperature in the pond fluctuates greatly during the year, from about 40°F or cooler in January to almost 100°F in August, especially in shallow areas... very tolerant of rapid temperature change and low oxygen content due to summer heat.

*Cyprinodon macularius*

Desert Pupfish



Photograph Courtesy of John Rinne

Desert pupfish declined due to the introduction and spread of exotic predatory and competitive fishes, water impoundment and diversion, water pollution, groundwater pumping, stream channelization, and habitat modification.



Aquatic Environments

Only 1% earth's surface:

- 1. Lakes → nutrients, clarity, NPP  
- oligotrophic  
- eutrophic
- 2. Streams → - Watershed
- 3. Rivers → - Runoff  
- Erosion
- 4. Inland Wetlands → Marshes, swamps, floodplains

Aquatic Environments

- oligotrophic

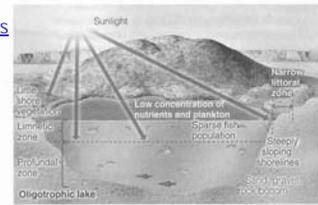
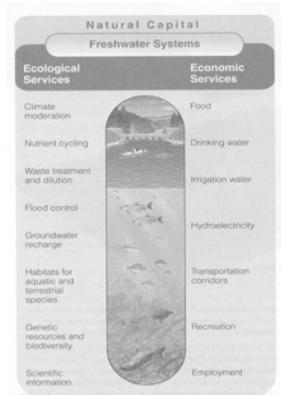


Fig 3-18, Miller, 2003

- eutrophic



Freshwater Ecosystem Services



Miller 2005  
Figure 3-18 Natural capital: major ecological and economic services provided by freshwater systems.

Ecological Services (e.g., rivers)

- Deliver nutrients to the sea that sustain coastal fisheries
- Deposit silt that maintains deltas
- Purify water
- Renew and nourish wetlands
- Provide habitats for aquatic life
- Preserve species diversity

**Figure 14-10** Some ecological services provided by rivers. Currently, the services are given little or no monetary value when the costs and benefits of dam and reservoir projects are assessed. According to environmental economists, attaching even crudely estimated monetary values to these ecosystem services would help sustain rivers.

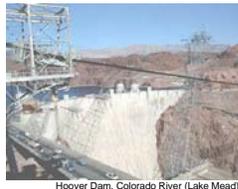
=12-11; Miller, 2003 (other)

Lessons from New Orleans?

What did the fish say when it ran into a concrete wall?



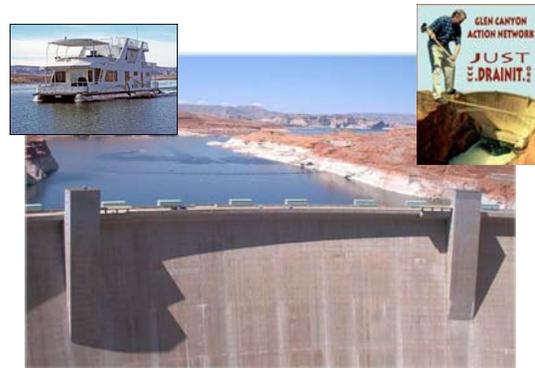
Dam!



Hoover Dam, Colorado River (Lake Mead)

Why build dams?

Why might dams be environmentally harmful?



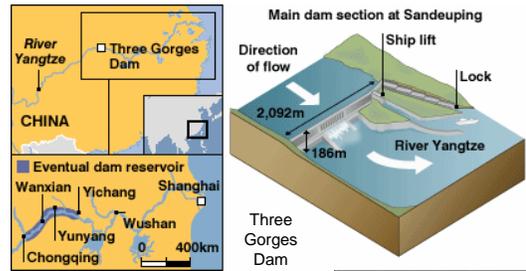
Glen Canyon Dam, Colorado River, Lake Powell



Three Gorges Dam



BBC News



When its 26 turbines become operational in 2009, the dam will have a capacity of more than 18,000 megawatts. Already the world's second-largest consumer of oil, China says it needs alternative energy sources to combat widespread power shortages and keep its booming economy powering along.



N 30° 23.270' W 68° 57.440'

08/31/2005 4:21:29 PM

Channelization and Floods



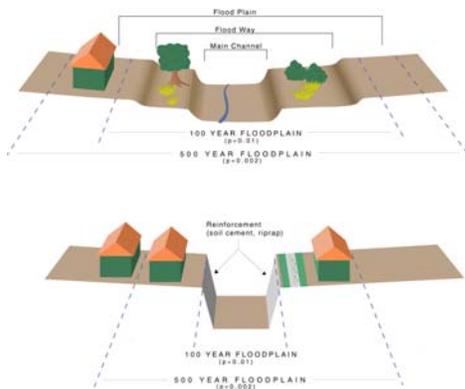
Rillito at First Ave. 1983 (Pete Kresan)



Santa Cruz at St. Mary's 1983 (Pete Kresan)

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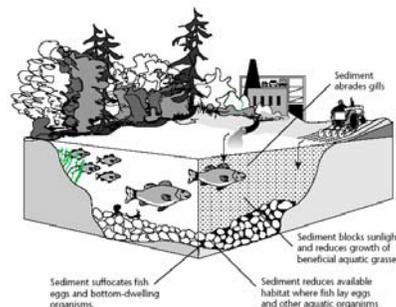
Channelization and Floods



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Figure 2-6

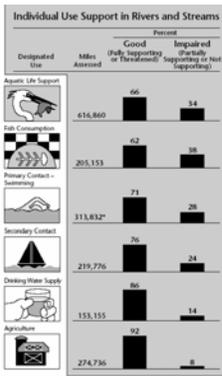
The Effects of Siltation in Rivers and Streams



EPA Report 2000

Siltation is one of the leading pollution problems in the nation's rivers and streams. Over the long term, unchecked siltation can alter habitat with profound adverse effects on aquatic life. In the short term, silt can kill fish directly, destroy spawning beds, and increase water turbidity resulting in depressed photosynthetic rates.

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This figure presents a tally of the miles of rivers and streams assessed by states for each category of designated use. For each category, the figure summarizes the proportion of the assessed waters rated according to quality.  
 \*0.0% used "Not Assessable."  
 Based on data contained in Appendix A, Table A.3.

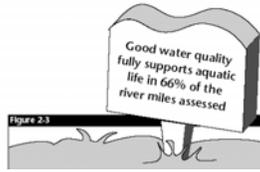
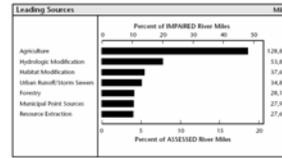
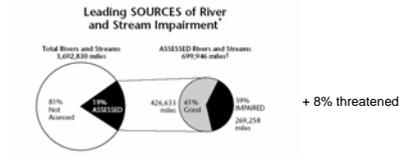


Figure 2.3

EPA Report 2000

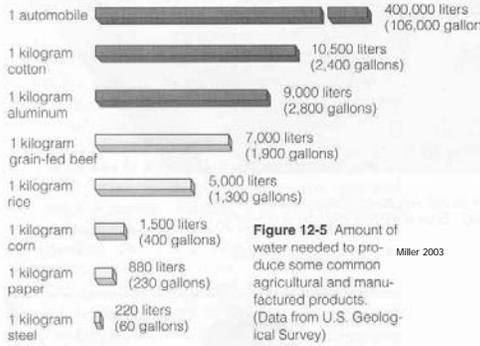
Figure 2.5



States assessed 19% of the total miles of rivers and streams for the 2000 report. The larger pie chart on the left illustrates this proportion. The smaller pie chart on the right shows that, for the subset of assessed waters, 61% are rated as good and 39% as impaired. When states identify waters that are impaired, they also describe the sources of pollution associated with the impairment. The bar chart presents the leading sources and the number of river and stream miles they impact. The percent scales on the upper and lower x-axis of the bar chart provide different perspectives on the magnitude of the impact of these sources. The lower axis compares the miles impacted by the source to the total ASSESSED miles. The upper axis compares the miles impacted by the source to the total IMPAIRED miles.  
 Based on data contained in Appendix A, Table A.5.

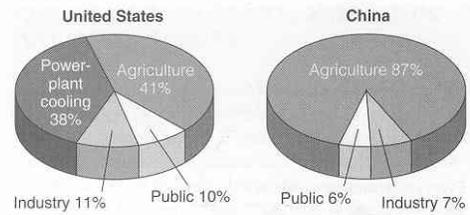
EPA Report 2000

Water Requirements



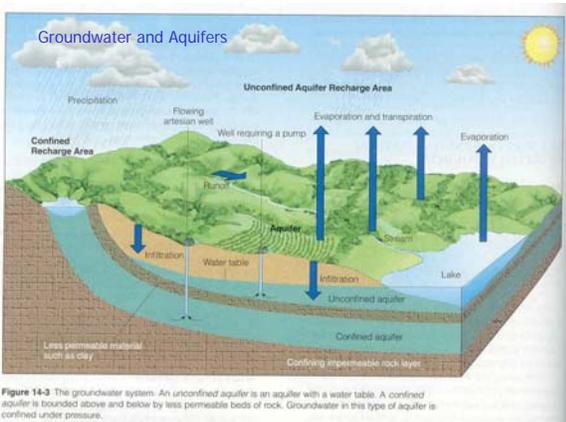
Water Ch 9

Water Use



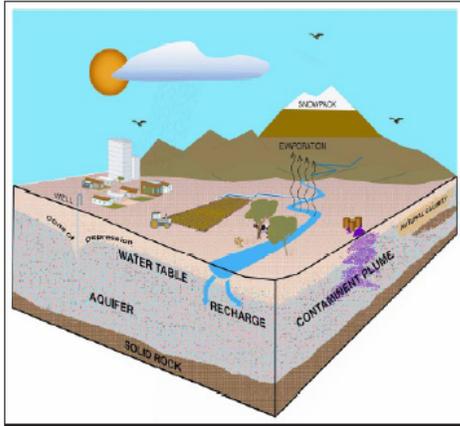
We're #1!

**Figure 12-4** Water use in the United States and China. The United States has the world's highest per capita use of water, amounting to an average of 4,800 liters (1,280 gallons) per person per day in 1999. Between 1980 and 1999, total water use in the United States decreased by 10% despite a 17% increase in population, mostly because of more efficient irrigation. (Data from Worldwatch Institute and World Resources Institute) Miller 2003



**Figure 14-3** The groundwater system. An unconfined aquifer is an aquifer with a water table. A confined aquifer is bounded above and below by less permeable beds of rock. Groundwater in this type of aquifer is confined under pressure.





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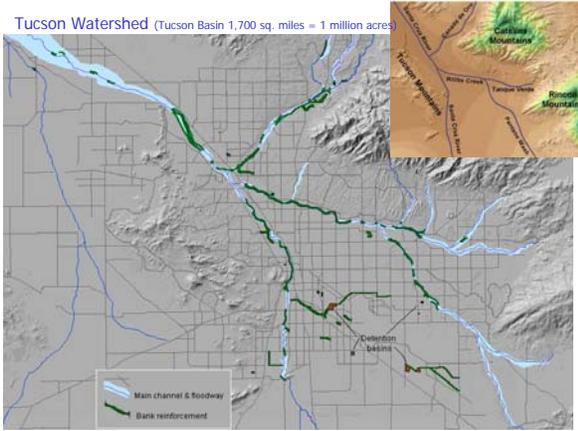
Watersheds

- Pacific
- Great Basin
- Gulf of Mexico
- Atlantic
- Hudson Bay
- Arctic



National Geographic 1993

Tucson Watershed (Tucson Basin 1,700 sq. miles = 1 million acres)



Watershed Management

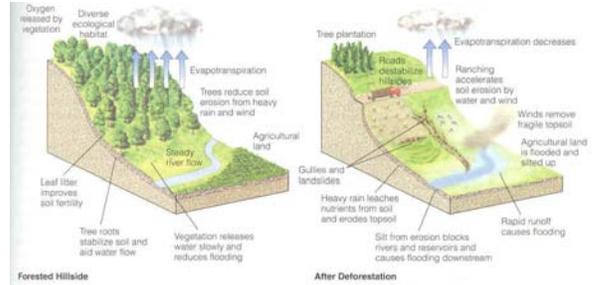


Figure 14-19 A hillside before and after deforestation. Once a hillside has been deforested for timber and farmed, livestock grazing, or unsustainable farming, water from precipitation (1) rushes down the denuded slopes, (2) erodes precious topsoil, and (3) floods downstream areas. A 3,000-year-old Chinese proverb says, "To protect your rivers, protect your mountains."

=12-10; Miller, 2003 (other)

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Who has water?

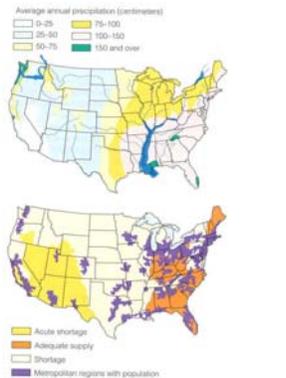


Figure 14-7 Average annual precipitation and major rivers (top) and water deficit regions in the continental United States, and their proximity to metropolitan areas with populations greater than 1 million (bottom). (Data from U.S. Water Resources Council and U.S. Geological Survey)

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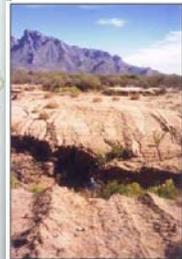
Water Use



Subsidence



Figure 14-13 Areas of greatest aquifer depletion and groundwater contamination (top) and ground subsidence (bottom) in the continental United States. Aquifer depletion is also high in Hawaii and Puerto Rico (not shown on map). (Data from U.S. Water Resources Council and U.S. Geological Survey)



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Stress on water basins

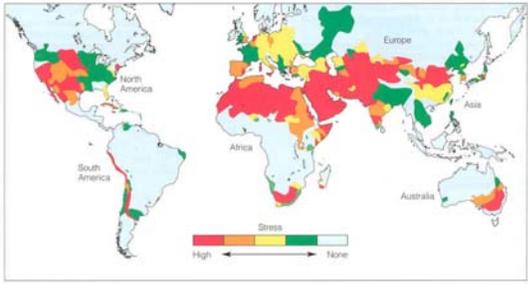


Figure 14-8 Stress on the world's major river basins, based on a comparison of the amount of water available with the amount used by humans. (Data from World Commission on Water Use in the 21st Century)

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Ogallala Aquifer (being depleted)



Figure 14-14 The Ogallala, the world's largest known aquifer if the water in the aquifer were above ground, is about 600 miles long and 50 miles wide. It is 1.5 feet thick. Water withdrawn from the aquifer is used to grow crops, raise cattle, and provide cities and industries with water. As a result, the aquifer, which is recharged very slowly, is being depleted (especially in the southern end) in parts of Texas, New Mexico, Oklahoma, and Kansas. (Data from U.S. Geological Survey)

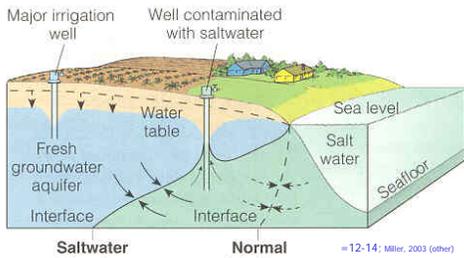
Irrigation  
Cattle Industry

- Nonrenewable

= p. 280; Miller, 2003 (other)

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Saltwater Intrusion



=12-14; Miller, 2003 (other)

Figure 14-15 Saltwater intrusion along a coastal region. When the water table is lowered, the normal interface (dotted line) between fresh and saline groundwater moves inland (solid line), making coastal groundwater drinking supplies unusable.

Moving Water



=12-12; Miller, 2003 (other)

Figure 14-11 The California Water Project and the Central Arizona Project involve large-scale water transfers from one watershed to another. Arrows show the general direction of water flow.

**Supply**  
On average, California receives 183 million acre-feet (about 2.4 trillions of gallons) of rain and snow a year. One of hundreds in the state, the great Central Valley aquifer holds 250 million acre-feet of accessible water.

**PRECIPITATION**  
The amount of California's rain and snow falls in the seasonally snow-capped Sierra Nevada mountains. The high Sierra provides an annual average of melting and evaporation.

**NATURAL RUNOFF**  
The rest of the state had a moderate to high snowpack, and the snow melts. The snow melts and runs off into streams and rivers. The snow melts and runs off into streams and rivers. The snow melts and runs off into streams and rivers.

**WATER PROJECTS**  
In the 1930s, the federal government started the California Water Project. The project is the largest of its kind in the world. It is the largest of its kind in the world. It is the largest of its kind in the world.

**FARM VS. CITY**  
The Central Valley Project is the largest of its kind in the world. It is the largest of its kind in the world. It is the largest of its kind in the world.

National Geographic 1993

**Delivery**  
More than half the annual runoff, or 43 million acre-feet, is captured by 1,200 reservoirs — then delivered in a gargantuan network of canals, aqueducts, and pipelines.

**NATIONAL GEOGRAPHIC 1993**

**Use**  
Agriculture takes 80 percent of captured runoff, leaving domestic, industrial, and environmental needs to vie for the remainder. For the Central Valley Project is a low line regulator that environmental requirements be satisfied first.

**FARM VS. CITY**  
The Central Valley Project is the largest of its kind in the world. It is the largest of its kind in the world. It is the largest of its kind in the world.

National Geographic 1993

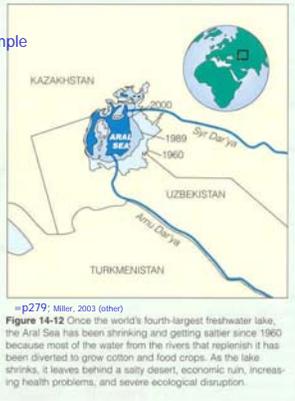
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Figure 11- CAP canal east of Phoenix

Central Arizona Project

Water Use Example



Aral Sea

Figure 14-12 Once the world's fourth-largest freshwater lake, the Aral Sea has been shrinking and getting saltier since 1960 because most of the water from the rivers that replenish it has been diverted to grow cotton and food crops. As the lake shrinks, it leaves behind a salty desert, economic ruin, increasing health problems, and severe ecological disruption.

Water Wars? (Religion, Ethnicity, Oil)  
Egypt and Sudan  
Syria and Palestine/Israel  
Turkey



Figure 14-1 The Middle East, whose countries have some of the highest population growth rates in the world, food production depends heavily on irrigation. Existing conflicts between countries in this region over access to water may soon overshadow both long-standing religious and ethnic clashes and attempts to take over valuable oil supplies.

Water Sustainability

- Not depleting aquifers
- Preserving ecological health of aquatic systems
- Preserving water quality
- Integrated watershed management
- Agreements among regions and countries sharing surface water resources
- Outside party mediation of water disputes between nations
- Marketing of water rights
- Wasting less water
- Decreasing government subsidies for supplying water
- Increasing government subsidies for reducing water waste
- Slowing population growth

Figure 14-33 Methods for achieving more sustainable use of the earth's water resources.

Water Efficiency



- Redesign manufacturing processes
- Landscape yards with plants that require little water
- Use drip irrigation
- Fix water leaks
- Use water meters and charge for all municipal water use
- Raise water prices
- Require water conservation in water-short cities
- Use water-saving toilets, showerheads, and front-loading clothes washers
- Collect and reuse household water to irrigate lawns and nonedible plants
- Purify and reuse water for houses, apartments, and office buildings

Figure 12-17 Methods for reducing water waste in industries, homes, and businesses.

**Richard Ducote**

### Council failed on water fees

The estimated \$1.5 million annual revenue from the proposed fee would reduce future general rate hikes for all customers. Such fees are common in many cities, including Phoenix, Las Vegas, Denver and San Diego.

The business industry was opposed, claiming that increasing the cost of a \$20,000 house to \$1,000 a month is 1,278 times more than the Tucson market. But it's hard to believe that adding such a fee to the price of an average new home would require construction and bank the land owner.

Environmental opponents to the proposed fee have argued that the fee would be used to fund construction for the future but to cover those structures. Without a fee to show to help new needs, all current customers will have to pay more.

What's better about the \$2 fee is that the proposed fee was developed under control circumstances to help growth occur.

Instead of continuing to charge all customers for all costs, that the world about some other burden for organizing the water system where the system is being expanded.

A failure to have had the proposed growth of 1,000 annual residential homes in within city limits, where about 50 percent of Tucson Water employees live.

With the proposed fee for new customers, which was endorsed by the council when it was approved by the city council in February, Tucson Water expects an annual rate increase of 2 percent every other year.

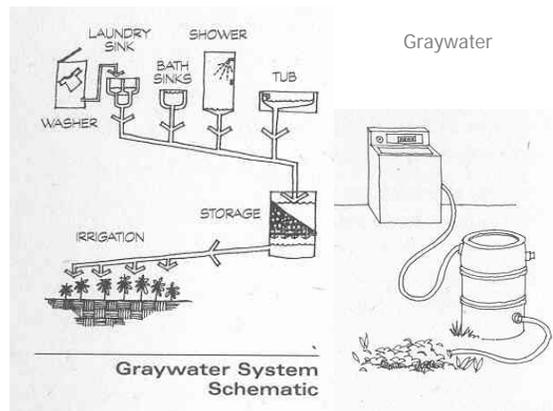
The four council members who unopposedly voted the fee proposed were Democratic Sen. Loni, Joe D'Arco and Shirley Scott and Republican Kathleen Dugan. Let's give a special mention to Dugan about the council's impact of the matter, reducing the price of water. That's a lower expense cost for low-income housing, ignoring the fact that Tucson Water had without the support of Habitat for Humanity and other groups by effectively subsidizing the small number of new households housing units from the fee.

It's not clear if the council majority is about to reach impact down end of year of a potential fee water or if they are just too worried by water.

This was an opportunity to show leadership and recognize that growth has costs and costs can be funded on growth. The majority failed, and the majority will suffer for it.

Richard Ducote is a columnist for Tucson Water and can be reached at 719 or [richard@tucsonwater.com](mailto:richard@tucsonwater.com).

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**Irrigation**

- Lining canals bringing water to irrigation ditches
- Leveling fields with lasers
- Irrigating at night to reduce evaporation
- Using soil and satellite sensors and computer systems to monitor soil moisture and add water only when necessary
- Polyculture
- Organic farming
- Growing water efficient crops using drought-resistant and salt-tolerant crop varieties
- Irrigating with treated urban waste water
- Importing water-intensive crops and meat

Figure 14-17 Methods for reducing water waste in irrigation. =12-16; Miller, 2003 (other)

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**Irrigation**

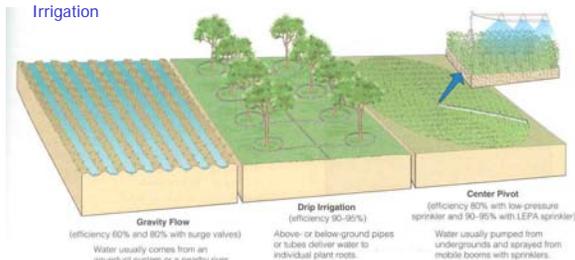
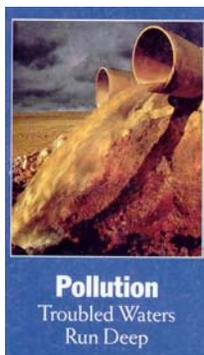


Figure 14-16 Major irrigation systems. Because of high initial costs, center pivot irrigation and drip irrigation is used on only about 1% of the world's irrigated cropland each. However, this may change because of the development of new low-cost drip irrigation systems (Solutions, p. 341). =12-15; Miller, 2003 (other)

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Point/Nonpoint



**Point vs. Nonpoint**

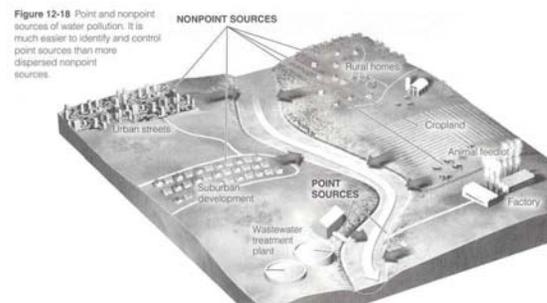


Figure 12-18 Point and nonpoint sources of water pollution. It is much easier to identify and control point sources than more dispersed nonpoint sources.

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**Arsenic**

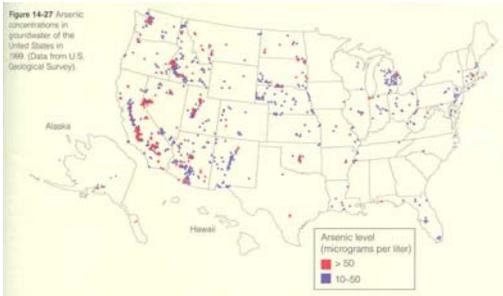


Figure 14-27 Arsenic concentrations in groundwater in the United States in 1999. (Data from U.S. Geological Survey).

CANCER

=p.292; Miller, 2003 (other)

**Ground Water Pollution**

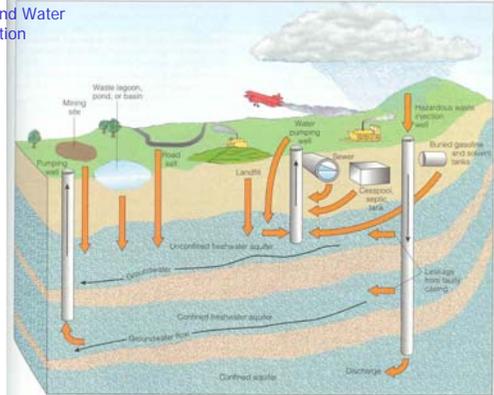


Figure 14-25 Principal sources of groundwater contamination in the United States. =12-22; Miller, 2003 (other)

Table 19-1 Major Categories of Water Pollutants States	Table 19-1; Miller, 2003 (other)
<p><b>INFECTIOUS AGENTS</b>  <b>Examples:</b> Bacteria, viruses, protozoa, and parasitic worms.  <b>Major Human Sources:</b> Human and animal wastes.  <b>Harmful Effects:</b> Disease.</p> <p><b>OXYGEN-DEMANDING WASTES</b>  <b>Examples:</b> Organic waste such as animal manure and plant debris that can be decomposed by aerobic (oxygen-requiring) bacteria.  <b>Major Human Sources:</b> Sewage, animal fecalions, paper mills, and food processing facilities.  <b>Harmful Effects:</b> Large populations of bacteria decomposing these wastes can degrade water quality by depleting water of dissolved oxygen. This causes fish and other forms of oxygen-consuming aquatic life to die.</p> <p><b>INORGANIC CHEMICALS</b>  <b>Examples:</b> Water-soluble (1) acids, (2) compounds of toxic metals such as lead (Pb), arsenic (As), and selenium (Se), and (3) salts such as NaCl in ocean water and nitrates (N) found in some soils.</p>	<p><b>Major Human Sources:</b> Surface runoff, industrial effluents, and household cleaners.  <b>Harmful Effects:</b> Can (1) make freshwater unusable for drinking or irrigation, (2) cause skin cancers and crippling spinal and neck damage (P), (3) damage the nervous system, liver, and kidneys (Pb and As), (4) harm fish and other aquatic life, (5) lower crop yields, and (6) accelerate corrosion of metals exposed to such water.</p> <p><b>ORGANIC CHEMICALS</b>  <b>Examples:</b> Oil, gasoline, plastics, pesticides, cleaning solvents, detergents.  <b>Major Human Sources:</b> Industrial effluents, household cleaners, surface runoff from farms and yards.  <b>Harmful Effects:</b> Can (1) threaten human health by causing nervous system damage (some pesticides), reproductive disorders (some solvents), and some cancers (gasoline, oil, and some solvents) and (2) harm fish and wildlife.</p> <p><b>PLANT NUTRIENTS</b>  <b>Examples:</b> Water-soluble compounds containing nitrate (NO<sub>3</sub>), phosphate (PO<sub>4</sub>), and ammonium (NH<sub>4</sub>) ions.  <b>Major Human Sources:</b> Sewage, manure, and runoff of agricultural and urban fertilizers.  <b>Harmful Effects:</b> Can cause excessive growth of algae and other aquatic plants, which die, decay, deplete water of dissolved oxygen, and kill fish. Drinking water with excessive levels of nitrates lowers the oxygen-carrying capacity of the blood and can kill unborn children and infants ("blue-baby syndrome").</p> <p><b>SEDIMENT</b>  <b>Examples:</b> Soil silt.  <b>Major Human Sources:</b> Land erosion.  <b>Harmful Effects:</b> Can (1) cloud water and reduce photosynthesis, (2) smother aquatic food webs, (3) carry pesticides, bacteria, and other harmful substances, (4) settle out and destroy feeding and spawning grounds of fish, and (5) clog and fill lakes, artificial reservoirs, stream channels, and harbors.</p> <p><b>RADIOACTIVE MATERIALS</b>  <b>Examples:</b> Radioactive isotopes of iodine, radon, uranium, cesium, and thorium (NU).  <b>Major Human Sources:</b> Nuclear power plants, mining and processing of uranium and other ores, nuclear weapons production, natural sources.  <b>Harmful Effects:</b> Genetic mutations, miscarriages, birth defects, and certain cancers.</p> <p><b>HEAT (THERMAL POLLUTION)</b>  <b>Examples:</b> Excessive heat from power plants (figure 19-20, p. 302) and some types of industrial plants. Almost half of all water withdrawn in the United States each year is for cooling electric power plants.  <b>Harmful Effects:</b> Lowers dissolved oxygen levels and makes aquatic organisms more vulnerable to disease, parasites, and toxic chemicals. When a power plant first opens or shuts down for repair, fish and other organisms adapted to a particular temperature range (Figure 4-13, p. 85) can be killed by the abrupt change in water temperature—known as thermal shock.</p>

**Great Lakes Basin Pollution**



Figure 14-24 The Great Lakes basin and the locations of some of its water quality problems. The Great Lakes region is dotted with several hundred abandoned toxic waste sites that are listed by the EPA as Superfund sites to receive cleanup priority (p. 386). (Data from Environmental Protection Agency).

<http://www.foxriverwatch.com/index.html>



PCBs  
Dioxins  
Etc.  
"polychlorinated biphenyls"

**Where tanks have leaked**  
 Underground fuel tanks have leaked fuel in water across Illinois.

**Closed gasoline stations have left a mauling legacy in Illinois.**

**Fuel additive MTBE found in water of 54 communities**

Experts say just one hole the size of a pin can leak 400 gallons of fuel a year, potentially tainting millions of gallons of water.

A cold measure: The Dept. of Transportation says it will require all new cars to have a fuel tank that is leak-proof for 10 years.

The study reviewed 300 of the state's best sites and found that, in most cases, the Dept.

## Factory Farms and Water Pollution



## Factory Farms and Water Pollution



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### Threats to human health

... The stench can be unbearable, but worse still, the gases contain many harmful chemicals. For instance, one gas released by the lagoons, **hydrogen sulfide**, is dangerous even at low levels. Its effects – which are irreversible – range from sore throat to seizures, comas and even death. Other health effects associated with the gases from factory farms include headaches, shortness of breath, wheezing, excessive coughing and diarrhea.

Animal waste also **contaminates drinking water supplies**. For example, nitrates often seep from lagoons and sprayfields into groundwater. Drinking water contaminated with **nitrates can increase the risk of blue baby syndrome**, which can cause deaths in infants. High levels of nitrates in drinking water near hog factories have also been linked to spontaneous abortions. Several **disease outbreaks** related to drinking water have been traced to **bacteria and viruses** from waste.

The widespread use of **antibiotics** also poses dangers. Large-scale animal factories often give animals antibiotics to promote growth, or to compensate for illness resulting from crowded conditions. These antibiotics are entering the environment and the food chain, contributing to the rise of **antibiotic-resistant bacteria** and making it harder to treat human diseases.

### Threats to the natural environment

The natural environment also suffers in many ways from factory-farming practices. Sometimes the damage is sudden and catastrophic, as when a **ruptured lagoon causes a massive fish kill**. At other times, it is cumulative – for example, when manure is repeatedly overapplied, it runs off the land and accumulates as **nutrient pollution** in waterways.

Either way, the effects are severe. For instance, water quality across the country is threatened by **phosphorus and nitrogen**, two nutrients present in animal wastes. In excessive amounts, nutrients often cause an explosion of algae that robs water of oxygen, killing aquatic life. One such algae type, *Pfiesteria piscicida*, has been implicated in the death of more than one billion fish in coastal waters in North Carolina. Manure can also contain traces of salt and heavy metals, which can end up in bodies of water and accumulate in the sediment, concentrating as they move up the food chain. And lagoons not only pollute groundwater; they also deplete it. Many factory farms use **groundwater for cleaning, cooling and providing drinking water**.

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