You can't just grow forever and hope that the environment will take care of itself.
Tim Flannery, Australian environmentalist

NATURAL RESOURCES

Australia's War on Drought

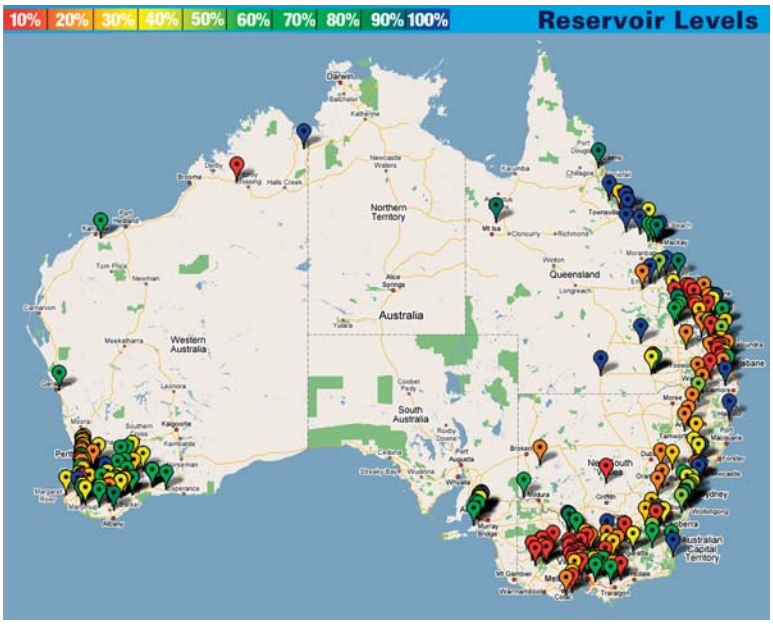
Watering the lawn and washing the car are quintessential parts of summer. Yet, in some parts of Australia these activities are illegal. That's because water is fast becoming the most precious commodity Down Under, so precious that every major urban center is under heavy water restrictions, and scientists are scouring the land for more water.

The shortage results partly from changing weather patterns—rain is falling at different times of the year and in shorter bursts. Australia is uniquely vulnerable to climate change, given the proportion of its relatively small land mass to the ocean that surrounds it; sea surface variations such as those seen with the El Niño–Southern Oscillation have a more profound effect here. According to the governmental *State of the Environment 2006* report, Australia—though a land of many climates—is overall the driest inhabited continent in terms of rainfall and streamflow.

Increased urbanization also plays a role. "The southeastern part of Australia where most people live is getting hotter and drier," says Tom Hatton, director of the Water for a Healthy Country Flagship, the water research arm of Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO). "If you project the demand of the five or six largest cities in the next twenty-five years, those cities are going to need up to forty percent more water, which we simply don't have."

CSIRO, in partnership with universities, governments, and private research agencies, has undertaken a massive project to find that water, spending AUS$80 million per year to find ways to increase the value that the country derives from water. One such innovation is the use of so-called Fleck sensors to monitor groundwater salinity, flow, and levels in virtual real time in a key agricultural area of Queensland. These wireless devices, which fit in the palm of a hand, feature long-range communication and solar recharging capabilities. The data they yield can be used, for example, to alert nearby sugarcane farmers if they are pumping too much groundwater before coastal seawater intrudes into the watershed.

The Fleck sensors are just one part of CSIRO's larger Water Resources Observation Network (WRON). The goal of the network is to collect current data quickly and accurately. "To produce a national report on water resources using manual methods would be hugely costly, [and] takes about six months and an army of people producing reports that are almost instantly out of date," says WRON manager Ross Ackland. "We need information systems that can produce something much quicker."



Mapping quest. A national water data collection network can yield comprehensive data such as this "widget" readout of reservoir levels across Australia.

The network is organizing all water information using a common framework. Some 100 to 200 different governmental, utility, industry, and research organizations currently collect water resource data, most of which is in proprietary formats. However, the new Web 2.0 technology of data aggregators—a news RSS feed is one well-known example—can help gather Australia's water information together. Visitors to the WRON website can download a Mac or Windows "widget" that collects data on Australia's dam levels and assimilates them into a standard format.

Although better management of water resources may help save water, it won't create more potable water—but desalination plants can. That's why the Water for a Healthy Country Flagship is also researching better ways to desalinate and recycle water. In May 2007, CSIRO and nine of Australia's universities combined their research efforts to form the Advanced Membrane Technologies for Water Treatment Research Cluster, with the goal of reducing the energy requirements of desalination by up to 50% and developing new materials to improve membrane performance.

Many desalination plants force water through semipermeable membranes to reduce salts and contaminants. Over time, these contaminants build up on the membrane, requiring cleaning or replacing and more energy to force water through the membrane's shrinking area. CSIRO is therefore exploring the use of membranes that bristle with carbon nanotube "forests," which trap contaminants while letting water flow through almost without friction, allowing a lower-energy method of desalination.

The CSIRO Water Reuse Technologies project is also tackling the hot issue of water reuse and recycling with a little help from Mother Nature, injecting wastewater into underground aquifers to remove a variety of pathogens, endocrine disruptors, and disinfection by-products. The rate of contaminant decay depends on the geochemical composition and biotic communities present in the aquifer. One town south of Perth reuses sewage water for irrigation after it spends only 30 to 40 days in an aquifer. The lead scientist on the project, Simon Toze, says, "The phosphates are probably removed by chemical properties or absorbed by limestone, whereas most of the nitrogen and pathogens are taken out by organisms using the contaminants as a food source." This practice not only improves water quality but may also give Australians a cheap and practical way to store water—a large concern as regular rainfall becomes more sporadic.
–Graeme Stemp-Morlock

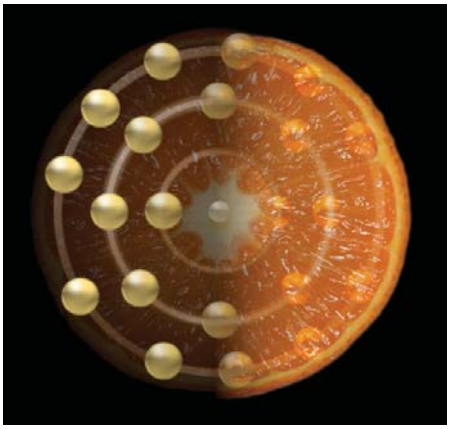
WRON

Chemical Exposures

Mutagenic Mix

The carcinogenicity of hexavalent chromium (Cr[VI]) likely arises from its ability to cause DNA damage and mutations. Nonetheless, its mutagenicity has been found to be modest and typically detected only at high exposure concentrations. But recent research indicates that the mutagenic and other genotoxic abilities of Cr(VI) become amplified 10- to 20-fold in the presence of ascorbate, or vitamin C.

OSHA and IARC estimate that nearly 400,000 U.S. workers and several million more worldwide are exposed to Cr(VI) in the workplace, where chromium compounds (or chromates) serve as anticorrosion agents in protective coatings, as pigments in paints and plastics, and in chrome plating on tools, aircraft engine components, railroad wheel bearings, and automobile parts. Long recognized as a potent respiratory carcinogen, skin irritant, and kidney and liver toxicant, Cr(VI) was also shown in a May 2007 technical report by the National Toxicology Program to cause cancer in rodents exposed through drinking water.



Most cells grown in culture contain little or no detectable vitamin C, and the strikingly high genotoxic potential of Cr(VI) was revealed only when cultured human cells were supplemented with physiologically normal levels of ascorbate. "We found that doubling of ascorbate concentrations in human lung cells caused a very strong increase in the number of chromosomal breaks even with low doses of [Cr(VI)]," says principal investigator Anatoly Zhitkovich, an associate professor of medical science at Brown University.

The dosage level was one-quarter of the current federal standard for total Cr in drinking water of 100 ppb (Zhitkovich explains that the typical Cr content in contaminated water is predominantly Cr[VI] because Cr[III] is poorly soluble). "Overall," he says, "we consistently found that the potentiating effects of vitamin C on genetic damage were always much stronger with low doses of chromium." Zhitkovich and his colleagues believe that their findings, published in the January 2007 (number 2) issue of *Nucleic Acids Research*, can be relevant to low-level exposures in environmental settings.

Previous studies over the past decade have shown that vitamin C is a key reducer of Cr(VI) in major organs. Extracellular vitamin C helps detoxify Cr(VI) by reducing it to the less toxic form of Cr(III), which is thought to be unable to enter cells. But even normal levels of vitamin C inside the cell could be hazardous, and the new study sheds light on the specific ways in which the genotoxic potential of Cr(VI) is enhanced by ascorbate. First, the reduction of Cr(VI) by intracellular vitamin C results in dramatic increases in the formation of chromosomal breaks and gene mutations. Second, the increased genetic injury results from abnormal processing of Cr(VI)-induced damage by the DNA mismatch repair machinery of cells in the G_2 phase of the cell cycle.

"This is the first truly thorough study on the role of ascorbate as an intracellular activator of chromate genotoxicity," says Kent Sugden, an associate professor of chemistry at the University of Montana. "These findings beg to be followed up with whole animal studies that should be able to show the impact of vitamin C supplementation with regard to chromate metabolism and carcinogenicity." The new findings, he adds, should serve as the basis for epidemiological studies of the impact of vitamin C on chromate metabolism in relation to cancer risk.

Sugden's views are echoed by Max Costa, a professor and chairman in the Department of Environmental Medicine at the New York University School of Medicine. "People differ in their levels of ascorbic acid, but at least we can control those levels since . . . all of our ascorbic acid comes from our diet," he says. "We now need a good population study that examines levels of ascorbic acid and chromate in red blood cells along with any associated genetic damage."

Zhitkovich and his research team are now concentrating their efforts on figuring out how vitamin C increases genetic damage caused by Cr(VI). "Our current hypothesis is that vitamin C promotes the formation of bulkier forms of Cr[VI]–DNA damage that are more mutagenic and toxic to human cells," he says. **–M. Nathaniel Mead**

Top to bottom: iStockphoto; Joseph Tart/EHP; Joseph Tart/EHP

Differing Risks from SHS

Research in the March 2007 issue of *Chest* reveals that black children may process secondhand smoke differently than white children do. Black children in the study had blood serum cotinine concentrations that were 32% higher than those of the white children studied. In black children with asthma, hair cotinine levels were up to 4 times higher than in white children with asthma.

This difference could help explain why blacks are more prone to tobacco-related health effects such as cancer, asthma, sudden infant death syndrome, and low birth weight, although the study authors state that more research is required to make definite associations. They add that these findings suggest there also could be differences in exposure or metabolism for other constituents of tobacco smoke, differences that might affect the development of disease.

Rate of Deforestation Slows

A recent UN FAO report contains some good news: the rate of global deforestation has started to slow. Deforestation accounts for 18% of the amount of carbon dioxide produced each year, due to the carbon sequestered in trees being released into the atmosphere. According to *The State of the World's Forests*, released in March 2007, the implementation of forest replanting projects in some countries has meant that the annual net loss of tree cover has declined from around 9 million hectares a decade ago to 7.3 million now. In addition, between 2000 and 2005, African countries designated 3.5 million hectares of forest as areas for conservation of biological diversity. The FAO found that economic growth can be good for forests, as wealthier countries are more apt to put in place policies for conservation.

GM Rice Given Go-Ahead

In March 2007 the USDA granted approval for Ventria Bioscience to grow rice engineered to produce human immune proteins. The proteins are intended for use in anti-diarrheal drugs and foods such as yogurt and granola bars. The company says a variety of controls will keep the plants from migrating to surrounding fields or being unintentionally mixed with other grains. Still, science policy and consumer advocacy groups oppose the plan, citing several instances in which genetically modified crops planted outdoors contaminated nearby crops. The same day the USDA released its draft environmental assessment of the Ventria rice project, it also revealed that a separate type of rice had been cross-contaminated with genetically engineered LL62 rice, which has not been released for marketing.

DIET AND NUTRITION

A Spoonful of Risk?

Soy foods are rich in isoflavones such as genistein and daidzein, strong antioxidants that bind to cells' estrogen receptors. For years, soy products have presented intriguing hints that they may confer protection against some cancers. For example, the incidence of prostate cancer among Asian males is far below that of U.S. males, with the former eating far more soy products than the latter. Now a large study offers more intriguing—and more confusing—evidence than ever.

Norie Kurahashi and colleagues at Japan's National Cancer Center used data from a 1995 cohort of the Japan Public Health Center-Based Prospective Study on Cancer and Cardiovascular Diseases to analyze diet and prostate cancer data for 43,509 Japanese men. Participants aged 45–74 had answered questions on medical history, lifestyle factors such as smoking, and how often they ate each of 147 foods. At the end of 2004, there were 307 recently diagnosed cases of prostate cancer in the cohort, of which 74 were advanced, 220 were localized to the prostate gland, and 13 were of undetermined stage.

The Kurahashi group found a dose-dependent lowering of risk of localized prostate cancer with increasing consumption of soy foods. However, further analysis showed that consumption of miso soup was associated with increased risk of advanced prostate cancer—men over age 60 who ate two or more bowls of miso soup a day were at twice the risk of advanced cancer as those who ate less than one bowl. And for men under 60, the risk for both localized and advanced prostate cancer rose with consumption of genistein, daidzein, and soy foods in general. The findings were published in the March 2007 *Cancer Epidemiology, Biomarkers and Prevention*.

Richard Hoffman, an associate professor of medicine at the University of New Mexico, points out that the Kurahashi study did not adjust for family history, a known risk factor for prostate cancer. Men with a family history of prostate cancer might try to prevent cancer by increasing their isoflavone intake. Therefore, he says, family history could confound the study results, producing a spurious association between higher isoflavone consumption and increased risk of advanced cancer.

Another possible confounder is that isoflavones, which are weakly estrogenic, inhibit testosterone production, thus limiting tumor growth but only as long as cells have estrogen receptors. However, as tumor cells develop, they lose those receptors, freeing up testosterone and making the tumors more aggressive.

Regarding the apparent protective effect against localized cancer, Kurahashi says, "Isoflavones might delay the progression from latent to clinical[ly] significant prostate cancer in Japanese [men]. However, when or how isoflavones affect latent or localized prostate cancer development and whether isoflavones can be used in the treatment or chemoprevention of this cancer are not yet clear." Kurahashi and colleagues will follow the cohort through two full decades and conduct nested case–control studies using archived blood samples in hopes of solving this puzzle. **–Valerie J. Brown**

INDOOR AIR QUALITY

Lemon-Fresh Ozone

Ionization air purifiers may be making our homes and offices more unhealthy places when cleaning products leave the air smelling lemon-fresh, according to research in the 1 April 2007 issue of *Environmental Science & Technology*. Scientists at the University of California, Irvine, report that ozone emitted by these purifiers reacts with certain volatile organic compounds such as limonene, producing potentially harmful levels of particulate matter (PM).

"In earlier work we showed ionization air purifiers, which are meant to remove particles from the air, to be producers of ozone, which itself causes a range of breathing problems and perhaps reduced resistance to infections," says Sergey Nizkorodov, an assistant professor of chemistry at Irvine. "Now we show this ozone reacts with limonene entering the air from cleaning products to produce more PM than these machines can actually remove." Limonene is used to scent cleaning products.

The researchers placed an ionization air purifier in an office equipped with a standard air exchange system. An ozone generator—a type of purifier that releases ozone to oxidize and theoretically neutralize volatile pollutants—was used as a comparison. D-limonene was injected into the room periodically to achieve concentrations similar to those encountered in offices after cleaning.

The ionization air purifier initially increased the ozone concentration by 5–15 ppb from a background level of 5 ppb, while the ozone generator raised it by some 250 ppb, according to Nizkorodov. With either machine operating, the limonene injections were accompanied by a spike of one to two orders of magnitude in the air's $PM_{2.5}$ and $PM_{0.1}$ content—from 10^3 to 10^5 particles per cubic centimeter—that decayed over the next hour. "This means that in [limonene's] presence, these air purifiers are actually air contaminators," says Nizkorodov.

The researchers also produced a kinetic model to predict the net amount of PM produced by different machines under different indoor scenarios. "The results obtained with the model fitted the experimental data very well," says Nizkorodov.

"The ultrafine particles produced by the reaction between volatile organic compounds and emitted ozone from ionization indoor air purifiers are of considerable interest since they are known to trigger oxidative stress and inflammation in the lungs," says Claire Infante-Rivard, a professor of epidemiology at McGill University in Montréal. "The results of the present study should attract the attention of public health authorities regarding the safety of these devices."

Peggy Jenkins, manager of the Indoor Exposure Assessment Branch at the California Air Resources Board, says that agency is currently developing a regulation to limit ozone emissions from indoor air-cleaning devices, especially ozone generators. "The Irvine results further support the need for this regulation," she says. "In addition to reducing the directly emitted ozone and its associated impacts, the regulation will reduce the likelihood of particle and formaldehyde formation when limonene or other terpenes are present indoors." **–Adrian Burton**

Lauren Donath

ehpnet

Australian Quarantine and Inspection Service

As part of the Australian government's Department of Agriculture, Fisheries, and Forestry, the Australian Quarantine and Inspection Service (AQIS) provides a host of essential services to help ensure that humans, animal and plant products, and even postal mail going to and from the country are healthy and do not pose a threat to Australia's unique environment. Its almost 3,000 employees inspect and certify agricultural exports, as well as oversee quarantine controls at Australia's borders. The AQIS website at http://www.daff.gov.au/aqis/ provides an overview of these activities.

The Importing to Australia section of the site has subsections for the different types of items coming into the country, along with a subsection of general information. The Cargo Containers subsection addresses topics such as high-risk pests found in imported cargo. One survey found that 13% of the 14,500 import containers inspected between December 1997 and June 2000 contained contaminants of quarantine concern.

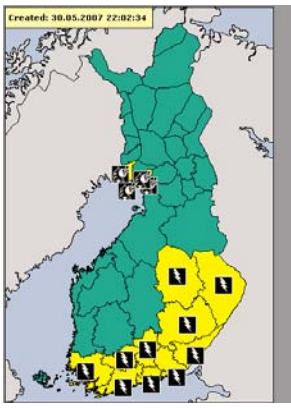
Quarantine measures help keep unwanted diseases and pests from entering Australia. One area of the country that is particularly vulnerable to these unwanted organisms is Northern Australia, which is separated from the islands of Southeast Asia by only very short distances. In 1989, the AQIS's Northern Australia Quarantine Strategy (NAQS) was established to focus efforts on protecting this area. The NAQS employs scientific surveys and monitoring to provide early detection of incoming pests such as disease-carrying mosquitoes. The NAQS subsection of the AQIS site provides fact sheets and other publications as well as a list of exotic pests, weeds, and diseases targeted by the NAQS.

The AQIS uses X rays and "detector dogs" to screen around 180 million items of mail each year in its efforts to keep unwanted materials out of the country. About 80,000 high-risk items of mail are intercepted in these manners annually. A section of the AQIS site provides a rundown of what the screeners are looking for and informs people as to why certain items are targeted, even though they can be purchased in Australia. The categories of targeted products include dairy and egg products, seeds and nuts, plant material, plants and soil, and live animals and animal products.

The Quarantine section of the AQIS site also has a page on the detector dogs program. These beagles, employed on 75 teams, are trained to detect more than 30 different plant and animal items and work at international airports, mail centers, and private courier depots around the country.

Also in the Quarantine section is a subsection on pests and diseases. One portion of this section looks at four mosquito-borne diseases—dengue, malaria, West Nile fever, and yellow fever—while another focuses on four weed species. The four weeds pages describe the species and tell where each is currently established, how it spreads, and how its presence and spread could affect Australia. A directory of pest and disease fact sheets is also available. **–Erin E. Dooley**

European Extreme Weather Alert



The weather services of 20 European countries have banded together to form a new website that provides alerts for forecasted weather events such as flash floods, severe thunderstorms, gale-force winds, heat waves, and blizzards, similar to information put out in the United States by the National Weather Service. The website, http://www.meteoalarm.eu/, also supplies 24- and 48-hour warnings for heavy fog, extreme cold, forest fires, and coastal events such as high waves or tides. The Meteoalarm site features a map of Europe with color-coded warnings for each participating country. Clicking on the desired country zooms the visitor in to district-level warnings along with details about the nature of the weather event.

Continental (Pollution) Drift

Many regions of Australia are in the grip of a drought that has been going on for more than five years. Now, scientists with the Australian research agency CSIRO have found that air pollution in Asia is affecting weather patterns in Australia. The researchers used a new computer climate model that shows aerosol pollution is changing the balance of wind and temperature between Asia and Australia, due to the cooling effect in the atmosphere of the haze of tiny particles from industrial and domestic sources that keeps solar radiation from reaching the Earth's surface. Currently, the effect is causing more rain in the northwest and center of Australia, and less precipitation in the more populated south and east regions of the continent.

Solving the Natural Gas Tank Size Puzzle

One of the cleanest burning alternative fuels is natural gas. In light-duty vehicles, natural gas produces 90% less carbon monoxide, 60% less nitrogen oxides and between 30 and 40% less carbon dioxide than gasoline. Until now, the use of natural gas in vehicles has been limited by the fact that the fuel storage tanks necessary were very bulky and required high-pressure conditions. Researchers at the University of Missouri–Columbia and Midwest Research Institute have come up with a solution in which ground corncobs are baked and compressed into carbon briquettes. These briquettes contain "fractal pore spaces"—spaces created by repetition of similar patterns at different levels of magnification—that can store 180 times their own volume of natural gas without high pressure and that can be fit into smaller areas. The technology is currently being tested in a truck owned and operated by the Kansas City Office of Environmental Quality.

Top to bottom: www.meteoalarm.eu; AQIS; University of Missouri–Columbia (MU)