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Surfing for Water Resources Information on the World Wide Web

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A new generation of computing resources will almost certainly make it easier to access and use information on water and other natural resources.

Use of the Internet -- the "information superhighway" -- is growing rapidly. Two factors are primarily responsible. Universities, federal, state, regional and local agencies are increasing the amount of information available over the Internet. At the same time, the ability of individuals to access the Internet is increasing as computers become more sophisticated and as more users are equipped for Internet access.

One set of resources available on the Internet is the World Wide Web (WWW). Simply put, WWW sites or "home pages" are computer sites that contain text and graphics. Individual pages are linked so users can move from one part of a home page to another and be referred to remote sites.

This issue of *Texas Water Resources* looks specifically at Texas water and environmental information available on the WWW. Features of the Texas Water Resources Institute (**TWRI**) WWW site -- Texas WaterNet -- are described.

This issue is not meant to be an all-inclusive listing of every WWW site dealing with water and natural resources issues, but we did try to find and list as many suitable sites as possible. Also, because the WWW is an evolving technology some of the addresses and sites listed here will change over time. We encourage users to let us know of new sites and changes or additions to existing sites as developments occur.

The Information Superhighway

It needs to be said up-front that this issue of *Texas Water Resources* will NOT be a detailed computer guide or user's manual. However, some basic guidelines will be explained. The "information superhighway" has become one of the buzzwords of our

generation. Everyone talks about it, but many people shrug their shoulders and ask--"What is it?" In general, the information superhighway is a worldwide network of computing resources that are linked electronically via the Internet. This technology is revolutionary because it allows many users with a few basic tools to instantly gain information from all over the world. To access the Internet, individuals only need a few basic items. Users need a computer. Typically, a 486-style PC or better or a Mac II or better should be sufficient. A high speed modem (14,400 bps will work but 28,800 is better) is needed to transmit data from the Internet to your computer. People working for a university, government agency, or large company may have a direct "hard-wired" connection. Otherwise, you need an Internet service provider. There are commercial Internet providers in many areas. Some type of WWW browsing software is required (Netscape and Mosaic are common choices).

TWRI Efforts: Texas WaterNet

TWRI has developed a WWW site, Texas WaterNet, that contains many tools that should be useful to individuals seeking water information. **Texas WaterNet** can be accessed at http://twri.tamu.edu/ When you log in, you will first see a graphic of a stream surrounded by eight black rectangles or buttons. Pointing and clicking on any of these buttons will let you access sites with more information.

This WWW site can help users find the water information they need in many ways, according to TWRI Director Wayne Jordan. "Texas WaterNet allows rapid, searchable access to databases that can be used to find more information about researchers working with water resources, to locate articles and reports that we have produced on particular topics, and to gather information on specific water issues. This complements our traditional role as a supplier of water related research news and information," Jordan says.

Texas WaterNet features a searchable on-line directory of water experts at Texas universities. The directory lets users search for researchers by name, institution, academic department, and keywords that describe work these scientists are conducting. If the researcher has provided an electronic mail address to TWRI, a form will be displayed that lets users easily send electronic mail to them. This part of the site also lets users learn more about TWRI staff and send e-mail to us.

The WWW site makes TWRI publications available to many more users who can access them more easily. Current and past issues of TWRI's four quarterly newsletters (*Texas Water Resources*, *New Waves*, *Texas Onsite Insights*, and *Texas Water Savers*) are provided. Abstracts of many TWRI technical reports and tables of contents of TWRI Conference Proceedings are also online. In the future, TWRI plans to publish the full text of its new technical reports on **Texas WaterNet**.

"The many advantages **Texas WaterNet** brings to our publications program are obvious," Jensen says. "We can put new issues of newsletters and technical reports on-line before they are printed and mailed. The WWW site also allows us to make color

photographs and graphics available, which we can't do in our printed publications because of cost limits."

A component of TWRI's WWW site that users may find helpful is the WaterNet Search tool. This lets users search all items on **Texas WaterNet** using keywords they choose themselves or terms already defined by TWRI. Users can then point and click to read the articles and reports they find.

A goal of TWRI's involvement in WWW activities is to provide expanded coverage of water and natural resources information from sites throughout the U.S. and internationally. With this in mind, **TWRI WaterNet** contains "hot links" to many related WWW sites at Texas universities and state and federal agencies, and sites with general information on water and environmental issues. Some of the links that may be especially useful are those to the ***National Institutes for Water Research*** (http://wrri.eng.clemson.edu/) and the ***Universities Water Information Network*** (http://www.uwin.siu.edu/).

TWRI is involved in other activities related to **Texas WaterNet**. TWRI recently began an electronic mail list called TWRI WaterTalk. Initially, this service is used by TWRI to distribute information about technical reports, research projects, and technology transfer projects. TWRI hopes this site will evolve into a tool that people can use to ask questions about and discuss water issues. You can subscribe to **TWRI WaterTalk** from the **Texas WaterNet** home page.

TWRI is beginning efforts to introduce public school teachers to the WWW. Jensen is now working on an environmental education mini-grant from the U.S. Environmental Protection Agency (EPA). The goal of this technology transfer project is to provide public school teachers with hands-on experience in how to use the WWW to gain information on water and the environment that they may want to incorporate into classroom teaching. Jensen is working with Glen Shinn of the Texas A&M University Agricultural Education Department to invite Central Texas agricultural and natural resources public school teachers to a workshop that will take place at Texas A&M University in January. At the workshop, teachers will get intensive instructions in how to use the components of **Texas WaterNet**. They will be tested about their knowledge of the Internet and how useful they believe it will be in teaching efforts, before and after the workshops. Jensen is trying to institute similar workshops for science teachers from other schools in the region.

WWW Efforts at Texas Universities

Many Texas universities are leading the way in developing WWW sites, in part because computing resources and skilled professionals are already in place. It's not surprising that they have begun developing high quality WWW sites dealing with water resources issues.

Throughout the Texas A&M University System, various research and extension centers are developing WWW sites with natural resources information:

Publications and photos developed by the Texas Agricultural Extension Service can be searched and accessed through the **Leviathan WWW site**. This site includes a comprehensive search engine to help users find the information they need and can be accessed by WWW browsers and Gopher software. The address is http://leviathan.tamu.edu/.

The ***Rangeland Ecology and Management Department*** contains information about research in its rangeland watershed laboratory and ecology and environmental sciences program. The address is http://ranch.tamu.edu/rlem/.

The Institute for Scientific Computation's ***Partnership in Computational Sciences*** features still color graphics and video segments about groundwater contaminant transport models. These models simulate how plumes of pollutants can flow into a typical aquifer system. This site describes research that was conducted to develop and operate these models. The URL is http://www.isc.tamu.edu/.

The ***Texas Agricultural Experiment Station's Blackland Research Center*** has established a WWW site that describes research projects and contains information on work in GIS, and simulation modeling of watersheds, drainage basins, and irrigation systems. Their address is http://brcsun0.tamu.edu/.

Most of these sites in this section contain technical information on water issues. However, easy to read information about water issues is also available:

The ***Texas A&M University Agricultural Communications Department*** has created a WWW site that contains press releases, graphics, photographs, and publications about the Texas A&M University Agriculture Program. The URL is http://agcomwww.tamu.edu/.

One of the first academic WWW sites in Texas was developed by Glenn Longley, Director of the ***Edwards Aquifer Research and Data Center at Southwest Texas State University***. The URL for this site is http://www.eardc.swt.edu/. It contains a large amount of data as well as text and graphics. Users of this site can access and download hydrologic information from a specific site in the Edwards Aquifer recharge zone by clicking and pointing on a computerized map. They can use that data to run a computer simulation model that projects how aquifer pumping strategies are likely to affect groundwater and spring levels at key points. This model was developed by the Center's Nisai Wanakule, with support from TWRI. This site includes hydrologic data, photos and descriptions of endangered species found at the Springs and in the San Marcos River, downloadable segments of educational videotapes about the region, and geographic information system (GIS) coverages.

The following three WWW sites have been developed at the ***University of Texas at Austin (UT)***:

David Maidment of the ***UT Civil Engineering Department*** created a home page that focuses on hydrology and GIS curriculum materials that can be accessed and used over the WWW. The URL is http://www.ce.utexas.edu:6000. Information at this WWW site includes how to create resources vital for GIS applications including watershed base maps, digital line graphs, land use and land cover files, drainage paths, and triangulated irregular networks. The site describes how to obtain hydrologic data via the Internet, and GIS and hydrology research at UT.

Other efforts at UT Austin focus on providing information on geology and groundwater resources. The ***Bureau of Economic Geology*** (BEG) WWW site contains information about research in such areas as hydrogeology, coastal resources, GIS, environmental assessments, and geophysics. The address is http://www.utexas.edu/research/beg/

The UT Walter Geology Library home page contains general references on geology and water resources. It features specialized information from statewide soil surveys, geologic and tectonic maps, and environmental resources of the Big Bend and the Llano Uplift. The URL is http://www.lib.utexas.edu/Libs/GEO/geology.html.

The WWW site developed by the ***Institute for Applied Science at the University of North Texas*** describes research projects dealing with aquatic toxicology, environmental archaeology, remote sensing, land use, GIS, environmental chemistry, reservoir limnology, and the impact of pesticides on water quality. The URL is http://pearl.ias.unt.edu/.

At ***Texas Christian University***, a WWW site has been established by the ***Center for Remote Sensing and Energy Research***. This site contains information about remote sensing and GIS research and how these technologies can be used to estimate erosion in watersheds and to analyze hydrologic characteristics of individual sites. The address for this home page is http://geowww.geo.tcu.edu/

The Water Resources Center at Texas Tech University has established a WWW server that describes their research and publications. It can be accessed at http://www.coe.ttu.edu/ce/WRC_home.htm.

Federal Agency Home Pages

Many federal entities are also creating WWW resources.

Divisions of the ***U.S. Department of the Interior*** (http://www.usgs.gov/doi/) have developed WWW sites, including the ***U.S. Geological Survey*** (http://www.usgs.gov/) and the ***U.S. Fish and Wildlife Service*** (http://www.fws.gov). The U.S. Fish and Wildlife Service (USFWS) site contains a searchable wetlands database and information from the National Wetlands Inventory on wetland and deepwater habitats and wetlands plant species.

The ***U.S. Geological Survey (USGS) Austin District*** has established a WWW site that contains a wealth of hydrologic and water quality data. Here, users can search for data on surface and ground water flows, water quality, sedimentation, water use, and floods. This data can then be downloaded and used in spreadsheet applications. Other resources at this site include "camera ready" fact sheets that can be viewed using Adobe Acrobat software, technical reports, access to the District's library, and descriptions of the USGS National Water Quality Assessment (NAWQA) studies in the Trinity River and Edwards Aquifer watersheds. The URL is http://txwww.cr.usgs.gov/.

Facts about the ***Galveston Bay and Corpus Christi National Estuary Programs (NEP)*** are available from the ***U.S. Environmental Protection Agency*** (http://www.epa.gov/). The NEP home pages include on-line newsletters, summaries of research projects, research goals, and management strategies developed by these programs. The address for the ***NEP*** home page is http://www.epa.gov/nep/nep.html.

The ***Federal Emergency Management (FEMA)*** WWW home page contains information on how to prepare for and deal with such disasters as floods, hurricanes, and severe storms, and with extreme heat. Maps that show the current and projected paths of hurricanes and natural disasters can be downloaded from this site. The address is http://www.fema.gov/.

Water resources information is available from the ***National Oceanic and Atmospheric Administration (NOAA)***. This site (http://www.noaa.gov/) contains links to the National Marine Fisheries Service, the National Climatic Data Center, the National Geophysical Data Center, and the National Weather Service. It describes NOAA efforts in inland and coastal fisheries, coastal ecosystems, weather forecasts, navigation, and endangered species.

The ***U.S. Army Corps of Engineers*** has developed WWW resources about water issues including separate home pages for their Water Resources Support Center, Hydrologic Engineering Center, Institute for Water Resources, Navigation Data Center, and Waterways Experiment Station. The location for the Corps' home page is http://www.usace.mil/usace.html.

The ***National Science Foundation (NSF)*** has created a WWW site that provides information on its activities that includes research into environmental and climate change issues, research opportunities, and NSF reports. The address is http://www.nsf.gov/.

Satellite photographs, images, and other remotely sensed information are available from the ***National Aeronautics and Space Administration (NASA)***. This WWW home page contains curriculum resources for classroom teachers. It is located at http://www.nasa.gov/.

The ***U.S. Department of Agriculture*** (USDA) WWW site (http://www.usda.gov/) contains information on research and extension programs in natural resources and the environment. This site provides links to the USDA/Agricultural Research Service (USDA/ARS), the USDA/ Natural Resources Conservation Service, the USDA/ Economic Research Service, state agricultural experiment stations and extension services, and the National Agricultural Library. ***USDA/ARS*** and the ***Texas A&M University Agricultural Research and Extension Center at Bushland*** have developed a WWW site with information on research in water management, agroclimatic data, and wind energy. This site contains links to other USDA/ARS home pages and is at http://www.net.usda.gov/cprl/.

WWW Efforts by State and Regional Agencies

An easy and efficient way to access water and environmental WWW sites developed by state and local governmental entities is the ***Texas Natural Resource Information System Navigator*** (http://www.twdb.texas.gov/) This site contains links to state agencies including the ***Texas Water Development Board (TWDB)***, the ***Texas Natural Resource Conservation Commission (TNRCC***), the ***Texas General Land Office (GLO)***, the ***Texas-Mexico Borderlands Information Center*** and other sites.

Information from the ***TWDB*** WWW site includes highlights of the Texas Water Plan, sales and purchases of water rights through the Texas Water Bank, data on freshwater inflows to bays and estuaries, water use statistics, and results of hydrographic surveys to measure sediment buildup in reservoirs. The address is http://tnris.twdb.state.tx.us:80/www/twdb/twdb_hp.html.

The ***TNRCC*** WWW site describes the agency's functions and organizational activities. Resources at this site include information about water resources and water management programs, including water utilities, water planning, agricultural watershed management, sampling and monitoring programs, permitting activities and pollution prevention. This site lets users download forms to apply for wastewater permits and the 1995 Texas Surface Water Quality Assessment. The URL is http://www.tnrcc.state.tx.us/.

The ***Texas General Land Office*** WWW site (http://www.glo.state.tx.us/) includes the Texas Coastal Natural Resources Inventory. The inventory will include a map that can be used to search for information on natural resources, geography, waterways, and sites of industries and oil and gas refineries. This resource is intended to help plan for and deal with coastal oil spills.

Regional water agencies are beginning to establish WWW sites:

The ***North Central Texas Council of Governments*** home page (http://www.nctcog.dst.tx.us/) includes the Trinity River Information Network (TRIN) and Water Resources in North Central Texas. TRIN features information on land use within the Trinity River corridor, highlights of the Trinity River "Common Vision" program, floodplain models, and images of the watershed. Water Resources in North Central Texas covers water quality planning efforts, wastewater treatment, management of urban stormwater, and groundwater resources.

The ***Lower Colorado River Authority*** WWW site includes information on the Colorado River Trail, the Highland Lakes, the Texas Environmental Center, daily reports on river levels and weather conditions, and links to other sites. The URL is http://www.lcra.org/.

The ***Red River Authority*** WWW site describes the Red River Basin Chloride Control Project, and summarizes work done for the Red and Canadian River Basins for the Texas Clean Rivers Program. The address is http://tnris.twdb.state.tx.us:80/www/red_ra/rra-hp.html

Other Groups Create WWW Sites

Many professional organizations, private companies, and special interest groups are creating WWW sites.:

The American Water Works Association (AWWA) home page describes AWWA databases, drinking water legislation and regulation, the WaterWiser water conservation clearinghouse, and the AWWA Research Foundation. The address is http://www.awwa.org.

The ***American Public Works Association*** (APWA) WWW page contains information on public works, wastewater management, water treatment, and the need to rebuild infrastructure dealing with water and other issues. Their URL is http://www.pubworks.org/apwa/.

Other associations with home pages on the WWW include the ***International Association for Environmental Hydrology*** (http://www.hydroweb.com/) and the ***International Association of Hydrogeologists*** (http://www.shef.ac.uk/uni/academic/D-H/es/iah.html).

Articles from ***U.S. Water News*** -- a national newspaper describing water news and information -- are also available. This WWW site lets users view news articles from current and past issues, participate in a discussion forum, subscribe to the printed copy of the newsletter, read about commercial products, and order books published by U.S. Water News and other groups. The URL is http://www.uswaternews.com/homepage.html.

The ***Consortium for Decentralized Wastewater Technology and Management*** describes national efforts in on-site wastewater treatment and management as well as descriptions of institutions that are working in this field. The URL is http://www.tuns.ca/wwater.

WaterWeb, contains links to sites that deal with such issues as point of use drinking water treatment technologies, water testing equipment and services, bottled water producers and equipment, and computer software and hardware. The address is http://www.waterweb.com/.

Note from the Editor

This issue of *Texas Water Resources* contains many URLs (electronic addresses, known as "Universal Resource Locators") for WWW home pages, shown in ***bold, italic*** text. We made every attempt to verify the URLs to make sure they are correct, but because WWW technology is changing so rapidly, many of these URLs are likely to change over time.

Many sentences containing URLs don't end in a period. That's because if a user adds an extra period to the end of a URL, the document won't be accessed properly. So we omitted nearby punctuation to avoid confusion.

Finally, you can avoid typing in the URLs manually. Just view this newsletter on the WWW, currently at http://twri.tamu.edu/twripubs/WtrResrc/v21n3/. The on-line version contains hyperlinks so the user can access the sites by pointing and clicking.

Ric Jensen,
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New TWRI Report Describes Rio Grande Salinity Issues

Increasing salinity levels in the Texas portion of the Rio Grande above Amistad Dam may threaten the amount of water that can be used for drinking or crop irrigation, according to a new study from the Texas Water Resources Institute (TWRI) and the Texas Agricultural Experiment Station.

The report, Flow, Salts, and Trace Elements in the Rio Grande: A Review (TR-169), was written by TAES scientists Seiichi Miyamoto and Lloyd Fenn of the Texas A&M University Agricultural Research and Extension Center at El Paso, and Dariusz Swietlik of the Texas A&M University-Kingsville Citrus Research Center at Weslaco. The report was developed by compiling, combining, and synthesizing existing information.

Miyamoto says that salinity is the major factor that limits how water can be used in the region. The highest salinity levels in the Rio Grande occur from Fort Quitman to Presidio (2,000 to 5,000 milligrams per liter or mg/l) and where the Pecos River enters the Rio Grande (2,000 to 4,000 mg/l).

Salinity levels above Amistad Dam have steadily increased since the 1950s. At some sites, they are greater than U.S. Environmental Protection Agency (EPA) limits for drinking water and guidelines for the water quality needed to irrigate high value crops. Meanwhile, salinity problems in Amistad Reservoir are also getting worse.

"The continuing increase in salinity levels in Amistad Reservoir is of special concern," Miyamoto said, "because it will further limit how water can be used in this arid region. The standard way of lowering high salinity levels is by providing increased freshwater flows, but unfortunately that's not a viable solution here because water supplies and surface water runoff are limited." Miyamoto said that alternative solutions to reduce

salinity levels may be minimizing flows of saline water into the River. This could be done by developing brine diversion dams or to reuse saline water to irrigate salt-tolerant grasses and other crops.

Miyamoto says that deterioration of water quality could have negative implications for high value agricultural production in the Middle and Lower Rio Grande. Many crops that are now grown in the region including chile and green peppers, onions, pecans, citrus, and peaches can thrive when salinity levels are moderate, but production could decrease if too much salinity occurs.

The report includes data on the flow of the Rio Grande and its tributaries and current levels of salts and trace elements. It compares existing contaminant levels in the River to water quality standards. The report recommends more studies on managing irrigation return flows, controlling salinity and salt loads, limiting sodium inputs, and trace element monitoring.

"This report provides an overview of how water quality in the Rio Grande watershed has changed over the past 45 years," Miyamoto says. "Because more salts and higher levels of sodium are building up in the river, there may be an increased likelihood that soils will deteriorate and will be less able to support high value crop production."

Other new reports include Effects of LCRA Lakes on Riparian Property Values (TR 170) by Lonnie Jones and Notie Lansford, and Soil Nitrogen Mineralization Potential for Improved Fertilizer Recommendations (TR 171) by Frank Hons, and Proceedings of the 1995 Water For Texas Conference ($30).

Summary

Providing water information over the Internet will be beneficial to many users. The benefits are obvious -- more people will get access to data and information will be easier to find. The use of technologies such as e-mail lists will provide a forum to communicate about water issues.

It needs to be recognized that the Internet does have its limitations. Although use if the Internet is increasing, many people don't even have a computer or know how to use the Internet and the WWW. The cost of buying a computer and accessing the Internet will limit the number of users.

How will TWRI deal with these issues? We will continue to publish printed newsletters, technical reports, and brochures. WWW activities will be enhanced to complement and supplement printed publications, not to replace them. This is expected to continue for the indefinite future. It is currently difficult to envision a scenario in which TWRI would abandon its printed publications and allow consumers only Internet access. The WWW lets people learn about our efforts and gain information quickly, but it's just a part of our technology transfer program. We still value people who prefer printed publications and will continue to meet their needs.