VOLUME 4, SPRING 2013

WATER MANAGEMENT & HYDROLOGICAL SCIENCE
TEXAS A&M UNIVERSITY

The Drop

WMHS PROGRAM NEWS

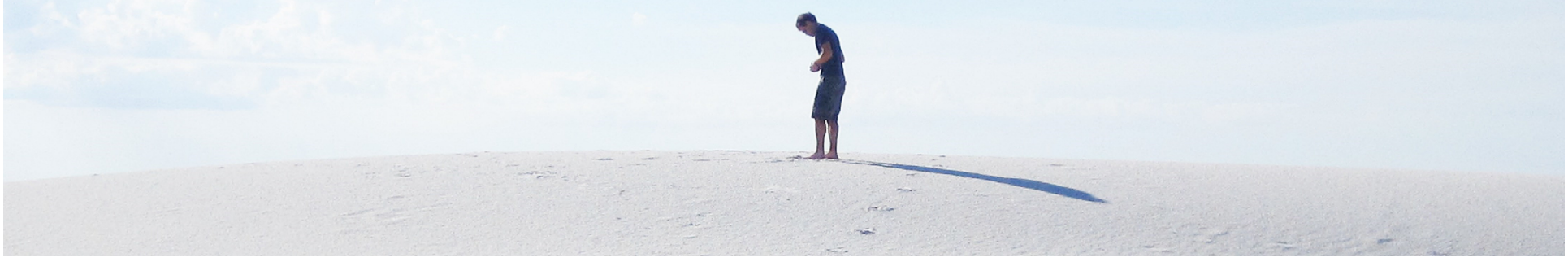
CUAHSI UNIVERSITIES ALLIED FOR WATER RESEARCH

WATER MANAGEMENT & HYDROLOGICAL SCIENCE TEXAS A&M UNIVERSITY

Texas Water Resources Institute *make every drop count*

WATER DAZE

April 24, 2013



Water Poster Competition

Place: Rudder Tower Exhibit Hall

Time: 9:00am to 4:00pm (judging from 2pm to 4pm)

Click here to register.

"Let's Talk About Water" and Movie Event

Movie: "Last Call at the Oasis"

Place: Rudder Theater (next to Exhibit Hall)

Time: 4:00-7:00

Let's Talk About Water: An Event Sponsored by CUAHSI

C. Prakash Khedun

LET'S TALK ABOUT WATER *Film & Water Symposia*

Water is vital for life. Life form, as we know, would not have existed on Earth without water. Water sustains life; the production of food and fiber would be impossible without an adequate source of water.

Not everyone, around the world, is privileged enough to have access to clean potable water. Eighty percent of diseases in developing countries are due to the lack of access to clean water. Each year more than five million people die from water-related diseases. A child dies from a water related disease every 15 seconds. By the time you finish reading this article, 4 children would have already died due to lack of clean water. This is happening for real, whether it is day or night.

Ironically, in the developed world, where people have access to state-of-the-art water treatment and conveyance infrastructure and a constant supply of clean potable water, some consider the water flowing out of their tap as "disgusting" and prefer to drink bottled water. It takes 3 liters of water to produce 1 liter of bottled water.

The amount of water available for consumption is small. Of the 1,400 million km^3 of water on the planet, about 97% is saline and less than 3% is fresh. Of the freshwater available, 68.6% is locked in ice caps and glaciers and 30.1% in fresh groundwater, and only 1.3% is available as surface and other freshwater sources.

While the amount of freshwater available is constant, demand for water has not stopped increasing. The world's population is growing at an astounding rate. Population more than doubled over the 20^{th} century to reach slightly over 6 billion in 2000, and another billion people

were added over the last decade alone. The UN projects that the world's population will exceed 9 billion by 2050, and 10 billion by 2100. Alarmingly, this growth is taking place within the poorest population in lesser developed countries; regions that also suffer from harsh droughts and extreme changes in precipitation and evaporation patterns.

Climate change is causing and intensification of the hydrological cycle. The effect of global warming is already being felt. More frequent and more severe droughts, flash floods, higher than average snowfall or persisting cold spells are all very likely as the climate changes. Mid-latitude countries may experience a decrease in annual precipitation and a decline in their water availability.

Do we have a water problem? You bet we do! So, *let's talk about water!*

The Water Management and Hydrological Science program at Texas A&M University is organizing a one day event entitled *Water Daze*. The event comprises a poster competition and a film screening followed by a panel discussion. The poster competition is open to all undergraduate and graduate students at Texas A&M University. Cash prizes will be awarded to the three best posters.

Let's Talk About Water (LTAW) consist of viewing a documentary following by a Q-and-A session with a panel of experts. LTAW was created by Linda Lilienfeld and is now run in partnership the Consortium of Universities for the Advancement of Hydrologic Sciences, Inc. (CUAHSI). The event is sponsored by a challenge grant from CUAHSI matched, 1:1, by the water program and the Texas Water Resources Institute.

Last Call at the Oasis will be shown in Rudder Theater followed by a one hour panel discussion. Last Call at the Oasis is directed by Academy Award winner Jessica Yu and is based on Alex Prud'homme's "The Ripple Effect". It discusses the present state and future of water. The film include conversation with James S. Famiglietti, professor at UC Irvine; Tyrone Hayes, professor at UC Berkeley; Peter H. Gleick, President of the Pacific Institute for Studies in Development, Environment, and Security; Aaron T. Wolf, professor at Oregon State University; and Erin Brockovich, environmental activist made famous by the movie that bears her name.

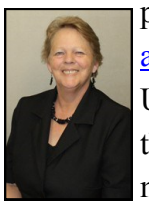
The panel will consist of experts in water planning and management, international water law, water conservation, water quality.

Panel Members

Dr. Kelly Brumbelow is a professor in the Water Resources Engineering department in the Department of Civil Engineering at Texas A&M University. His area of expertise include water resources planning and management, security of water distribution systems, decision support systems, climate variability and change and the assessment of water resources policy.

Dr. Gabriel Eckstein is a professor of law at Texas Wesleyan School of Law. He is also the director of the International Water Law Project and a senior fellow at the Center for Water Law and Policy at Texas Tech University. His expertise is in water and environmental law and policy at both the US and international levels. He has served as an expert advisor and consultant on a number of US and international initiatives.

Dr. Calvin Finch is currently the director of the Water Conservation and Technology Center (WCTC) in San Antonio. The goals of WCTC "are to accelerate development and adoption of new and innovative technologies to solve emerging water problems and meet future water supply needs."



Dr. Jacqueline A. Aitkenhead-Peterson is a professor in the Department of Soil and Crop Sciences at Texas A&M University. Her research focusses on the linkages between land management practices and ground and surface water chemistry, the mechanisms that influences carbon, nitrogen and phosphorous cycling and loss to surface water under different land uses within watersheds.

Ms. Jennifer Nations is the Water Resource Coordinator for the City of College Station and the chair of the Texas Section of the AWWA Water Conservation and Reuse Division.

Dr. Ismael Aguilar Barajas is a professor of economics at the Mexico and Latin America Water Center at Monterrey Institute of Technology and Higher Education. He is also a member of the National System of Researchers through CONACYT and has experience working with the federal government of Mexico as well as both the public and private sector. His current research includes water planning in the US-Mexico border region, water economics, and sustainability.

HARD WATER

Weather Modification

Part 1 of 2: History, Theory, and Research

By James Sweeney

Background

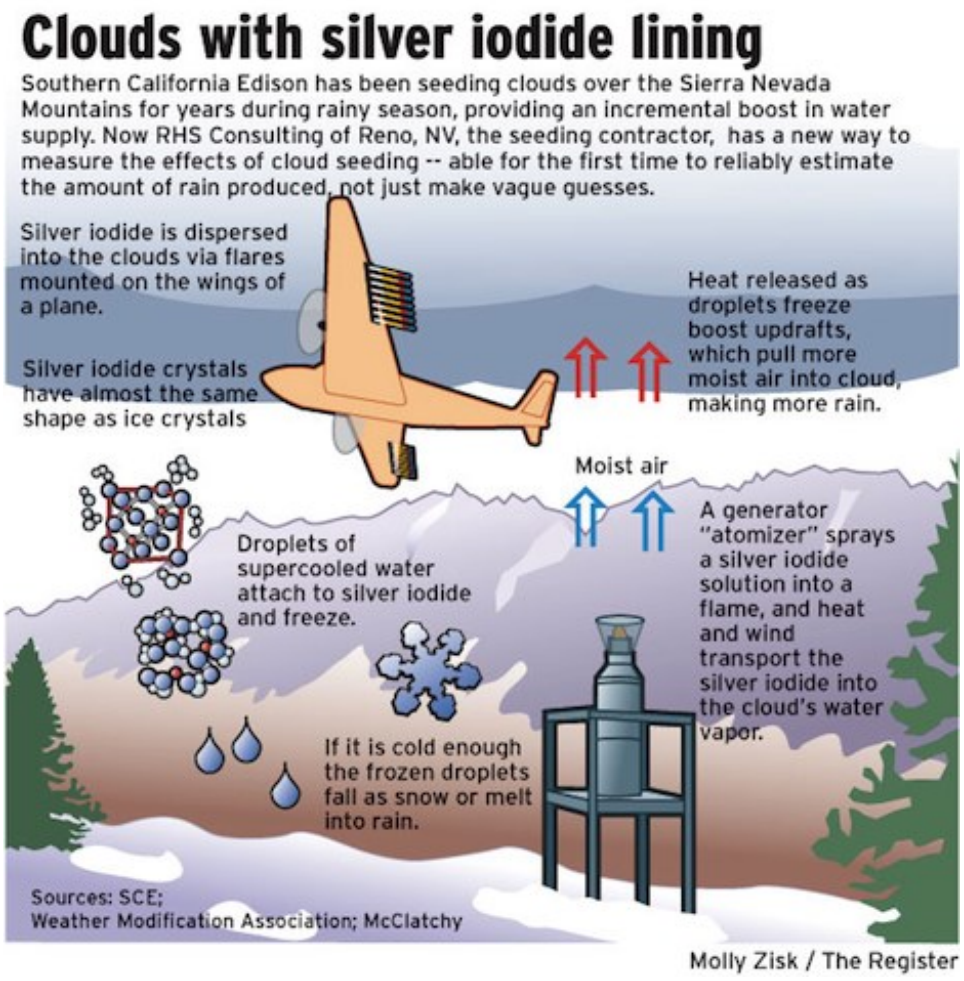
Water, engaged in perpetual change, moves through various stages on Earth through the hydrologic cycle. Humans engage this natural resource more and more as the populations rise. Whether through drinking water, sanitary disposal of human waste, industrial process use, agricultural irrigation, recreational use, runoff or industrial contamination, our most precious natural resource is being used, reused and contaminated. More and more water is becoming scarcer in certain places, and its availability is a major social and economic concern. There are approximately one hundred and sixty thousand public drinking water systems in the United States that comprise around seven hundred thousand miles of water distribution mains providing inter-basin transfers and vital piping directly to human populations. The management of the aqueous environment and its sources and sinks is a major, costly but vital undertaking. Agricultural and urban demands on groundwater are ever increasing.

Texas, in particular, has plenty of water, but typically the water resource is located in the "wrong" place. To fix water shortages in one area, some think the solution is to buy water rights from others. Inter-basin water transfer has great potential to augmented water supplies in Texas but it is wrought with political and other turmoil. Additionally, inter-basin water transfers are very expensive and require much energy to pump water from region to region. Fiscal, environmental, legal and political reasons often find inter-basin projects delayed or abandoned all together. During periods of long droughts water budgets are extremely tight and a resurgence of a controversial method that attempts to help precipitate the water out of the atmosphere is gaining momentum in Texas and all over the world.

These techniques are often referred to as weather modifications. Weather modifications are

focused on controlling precipitation and fog in the atmosphere. Also known as cloud seeding, it attempts to change the amount or type of precipitation that falls out of clouds, or their structure, by dispersing substances into the air which allow water droplets or ice crystals to form more easily. The most common chemicals used for cloud seeding include silver iodide and dry ice (frozen carbon dioxide).

Texas Department of Licensing and Regulation has produced research stating statistical seeded clouds in Texas during 2005 (a total of 494) estimated that an additional 129,272 acre-feet of water was generated by the seeding of single-cell thunderstorms. With more complex multi-cell storms added to the study, the analysis estimated as much as 2.3 million acre feet was produced above and beyond what those clouds would have furnished had they not been seeded.



Pioneers and Theory

Pioneers

A brief look into the history of cloud seeding demonstrates a small group of early researchers and a core group at the General Electric Corporation. It is often noted that a chemist named Vincent Schaefer on November 13, 1946, modified clouds in the Berkshire Mountains by seeding them with dry ice. R.B. Standler notes that there are at least three earlier scientific attempts to seed clouds, and some with successful results. A Harvard University professor, Emory Leon Chaffee, dispensed charged sand from an airplane during 1924, to attempt to modify weather. In 1930 W. Veraart dropped dry ice into clouds with the intent to modify the weather. According to Standler, his results were only published in his book which was in Dutch. Additionally, in 1938, a MIT professor named Henry G. Hougton sprayed hygroscopic solutions into fogs in an attempt to modify (in this case dissipate) the weather.

It was Schaefer and his associates at General Electric that researched and built the foundations of the cloud seeding science. One such associate was Bernard Vonnegut who discovered a chemical very similar in molecular structure to dry ice; it was silver iodide. Dr. Vonnegut worked at noted physicist Irving Langmuir's laboratory at General Electric. It was immediately recognized that the potential liability of these studies demanded government sponsorship and soon after a contract was acquired with the U.S. Army Signal Corps.

Langmuir and Vonnegut continued studies in the late 40s and early 50s. Seeding experiments on hurricanes and controversial results in New Mexico and affects on neighboring Kansas applied pressure to General Electric. In an effort to decrease its liability, General Electric released its weather modification patents in December of 1950. This opened the doors for companies and experimenters alike to alter nature.

Basic Theory

The basic theory of cloud seeding centers on the general physics of clouds. A cloud is a visible mass of condensed droplets (water vapor) or frozen crystals suspended in the atmosphere above the surface of the Earth. Precipitation occurs when moist air is lifted to high altitudes where cooling causes water vapor to condense or freeze, forming clouds. As the air ascends the pressure on it decreases and the air mass expands thereby causing the water vapor to cool. Tiny clouds or water droplets must condense on even tinier dust, salt, or smoke particles. These particles act as condensation nuclei. Once the droplets weight overcomes the updraft speed they will fall out as precipitation.

Two principal processes of precipitation are theorized to form precipitation. They are the ice-crystal process and the coalescence process. The ice-crystal process occurs when the water vapor and condensation nuclei form ice-crystals in supercooled clouds (less than 32° F). If these ice-crystals do not develop the cloud droplets can possibly evaporate. If these cold-clouds do not form ice-crystals, raindrops can only form through the processes of coalescence. Coalescence is the process by which two or more droplets or particles merge during contact to form a larger combined droplet. The droplets in a typical cloud are so small that it takes about a million of them to make one raindrop. This process is dominant in warm-clouds.

Cloud Seeding introduces condensation nuclei into clouds (see Figure 1). Depending on the cloud seeding potential and cloud temperatures, different "seeds" can be introduced. Water loving, hygroscopic particles can accelerate the warm-cloud process. Ice nuclei, such as silver io-

EDITORS

Rosario Sanchez is from Saltillo, Mexico. She has her Masters in Diplomatic studies from Matias Romero Instituto and a PhD in Water Management and Hydrological Sciences at TAMU (Class 2009). She is now the Program Coordinator of the WMHS Program and her research interests are water planning, water policy development and international-transboundary water law.

James F. Sweeney is originally from Houston, Texas. He has a Bachelor's of Science in Bioengineering and a Master's of Engineering in Civil Engineering (Environmental), both from Texas A&M University. His research interests are on water and energy management, water policy and law, ecosystem management, and remote monitoring and sensing technologies. His PhD research is on the evaluation of the sustainability of a modern residential home. He is a Sr. Research Associate at Texas A&M University and anticipates graduating in the fall of 2013.

Peter Min-cheng Tu is from Taipei, Taiwan. He has master's degrees in aerospace engineering (Purdue University) and law studies (University of Pittsburgh). His Ph.D. dissertation will focus on evaluating the parameters effecting performance of control measures for urban storm runoff by inverse modeling water quality parameters derived from satellite imageries. He anticipates graduating in fall of 2013.

dide particles and dry ice pellets can supply some clouds with additional ice particles and thus increase the efficiency of the cold-cloud process. In addition to creating more sites for ice nuclei, the freezing of the seeds releases heat to the cloud environment. This heat adds to the energy of the cloud and can increase its intensity and/or duration. Seeding is done by the air and the ground. Airplanes are used to deliver the seeds. Ground-based generators or rockets also force seed material into the clouds from the ground.

Early Adopters

1950s-60s

In the early days of weather modification there was much optimism and a flurry of activity in Texas, Colorado, North Dakota and Kansas developed. In Texas, numerous "rainmaking" endeavors occurred during the epic drought of the 1950s, and some continued into the 1960s. Operational cloud seeding also got its start in North Dakota in the 1950s, when ground-based seeding activities began in the west.

In Texas in 1959, ranchers filed suit against Southwest Weather Research, Inc. asserting that cloud seeding would lessen the impact of rainfall on their lands. The Texas Supreme court would later rule that cloud seeding could continue because all Texans were entitled to the water above them, even in the clouds. This was a significant beginning to the inclusion of weather modification in the state laws.
In North Dakota in 1961, the beginnings of what is today's North Dakota Cloud Modification Project came about when Bowman County farmer-ranchers joined forces with pilot neighbors. They formed Weather Modification, Inc., the state's first all-airborne commercial cloud seeding company. Locally sponsored, the company began seeding first for just a few townships, then later entire counties, the program expanded and spread eastward throughout much of North Dakota.

In 1967 Texas Legislature adopted a law governing the use of weather modification technologies. The state of Texas encouraged weather modification studies and experiments. Jensen states that Texas had projects to reduce hail damage in the High Plains and cloud seeding was investigated as a way to ward off droughts in the Edwards Aquifer area, Corpus Christi, and West Central Texas. Texas water districts also often sponsored research efforts during this period. San Angelo and the Colorado River Municipal Water Districts in Big Spring Texas sponsored research into the affects of cloud seeding on agriculture and water resources.

1970s-1980s

In Colorado, one of the largest earlier seeding experiments in the United States started up in the 1970s. In an effort to suppress hail and understand the physics of summer storms the National Hail Research Experiment (NHRE) was inaugurated in 1971. NHRE, based at the National Center for Atmospheric Research (NCAR) conducted and performed numerous studies from 1972 to 1976. At NHRE thunderstorms were seeded with silver iodide in an attempt to create smaller, less damaging hailstones or even rain. The results were unclear. The 1970s was the second driest decade on record, and in one summer, 1973 there were fewer hail days compared to the previous year. By 1975, the seeding program was suspended, two years short of the original goal. Although the experiment failed to confirm any reliable effect from the silver iodide seeding it was regarded highly, producing insight into processes taking place in hailstorms.

Texas was active with cloud seeding activities during the 1970s. Hail suppression became a very hot topic with the newly formed Ranchers and Farmers Association for Natural Weather. This association claimed that cloud seeding lowered the amount of rain their area would normally receive. By 1977 hail suppression programs were suspended. From 1974 to 1980, a major cloud seeding for rainfall experiment was jointly conducted by the U.S. Bureau of Reclamation and the Texas Water Development Board. The main purpose of this study was to determine if rainfall could be increased in the high plains of West Texas. Its focus was on warm-season clouds. The study generated promising results about the nature of rainfall formation and the cloud physics needed for rainfall. A few years later in 1983 the Southwest Cooperative Program in Weather Modification Research produced promising results in "suitable clouds" increasing rainfall and cloud properties with cloud seeding. Suitable clouds were wet, multi-celled convective formations. The program continued until 1990 and analysis concluded 130% increases in rainfall and significant increases in cloud size and duration.

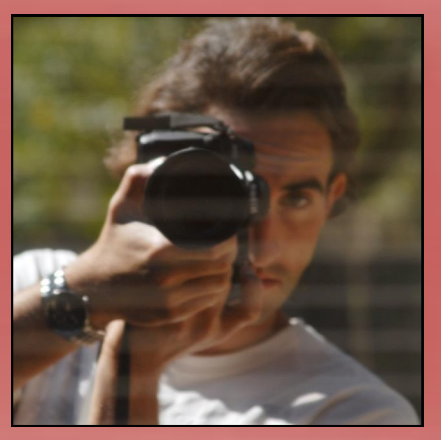
Although little was known about how the hail suppression effect came about within the clouds, North Dakota was very interested in taming the hailstorms in the 1970s, especially in western North Dakota. In 1975, the state-supported North Dakota Weather Modification Board (NDMCP) was created as a division of the Aeronautics Commission. A year later, state cost-sharing was available for the program and a total of 17 counties participated in the NDCMP.

Similarly, in 1974, the Western Kansas Weather Modification Program began under the Western Kansas Groundwater Management District #1 (WKGMD #1). The WKGMD #1 identified goals and specific objectives and was to organize, design and implement an operational weather modification program to seed convective clouds to increase rainfall and help alleviate the losses of sub-surface water in Western Kansas. During this period s there was much dispute on the reality of the results that a thorough review of a research program known as the Kansas Cumulus Project (KANCUP) and from state-sponsored seeding programs being conducted in the Dakotas. The review was promising and Kansas embraced cloud seeding at the government level.

In 1980 the United States joined the fray and a federally funded research program was undertaken to develop an understanding of the physical processes involved in hail and precipitation formation and modifications for human use. Known as the Federal-State Cooperative Program in Atmospheric Modification Research, the program was funded by National Oceanic and Atmospheric Administration (NOAA). The program had a budget of a half a million federal dollars per year. By 1994 the budget was cut.

Look for Part 2 in the next edition of The Drop.

EDITORS



Alan Lewis is from Newbury Park, CA and earned his bachelor's degree in Civil & Environmental Engineering at UCLA in 2010. His thesis work focuses method for predicting evaporation over Texas lakes and reservoirs through GIS. During the summer of 2012, he conducted web development at Alpha Reclaim Technology, LLC in Bryan, TX. Upon graduation, Lewis hopes to go on to work for an international civil engineering firm and work towards a PE.

Janet Torres is from Chicago, IL. She earned her bachelor's degree in Urban & Regional Planning at the University of Illinois, Champaign-Urbana in 2010. Her thesis work focuses on water quality issues in the Municipality of Marcos Castellanos in Michoacán, Mexico. Janet also works for the College of Geosciences as Assistant to the Director of Recruitment and is an L.T. Jordan Fellow. Following her anticipated graduation in summer 2013, she hopes to pursue a PhD or work with the UN or another international organization to improve living standards in developing countries through better planning.

Not All Trees Are Created Equal... Especially For Droughts!

By Peter Min-cheng Tu with Ray Kamps

Texas is experiencing the worst drought since the 1950s, and the Texas A&M Forest Services estimated up to 500 million trees have been killed by the drought condition. Surprisingly, the Brazos Valley region (yes, it is where we are!) has taken the heaviest hit with almost 10% trees on State Forestland lost. If we compare this fact with the U.S. drought map, it is easy to see that the most tree kill is not coincident with the region suffering from the most serious drought. Why is it? One possible explanation is that different trees have different survival strategies.

This hypothesis can lead to interesting questions. For example, is drought a driving force to change the landscape from dominated by one tree species to another? Under what circumstances does the driving force start to become prominent? How is the transition taken place?

Mr. Ray Kamps, a Ph.D. candidate in the water program of Texas A&M University, is trying to solve these questions. He is interested in two common species of trees in the Texas Hill Country near San Marcos: Plateau Live Oak and Ashe Juniper. As told by Ray, it is known that these two species use totally opposite drought survival strategies: Plateau Live Oak closes stomata (pores on leaves) during hot summer afternoons, while Ashe Juniper keeps stomata open longer and uses other mechanisms to compensate for water loss. What is implied by these two strategies is more complex than they appear: water and carbon dioxide are both needed for photosynthesis, but opening pores (stomata) on the leaves to allow carbon dioxide to enter also allows water vapor to leave. Conversely, closing the stomata to keep the water vapor inside the leaves starves the plant for carbon dioxide. The "choice" to the plants is to die of starvation or to die of dehydration. Therefore, different intervals and intensities of drought can have drastically different outcome (in terms of survival rate) for each of the species. Currently, Ray is using two sets of tools in order to gain a better understanding.

The first tool is eddy covariance. It is a complex method of measuring the appearance or disappearance (called fluxes) of carbon dioxide, water or energy into or out of the atmosphere from an area. When carbon dioxide disappears from the atmosphere during a sunny day, photosynthesis is considered as the reason. When it appears in the atmosphere at night, the assumed reason is respiration. Respiration cannot be measured directly during the

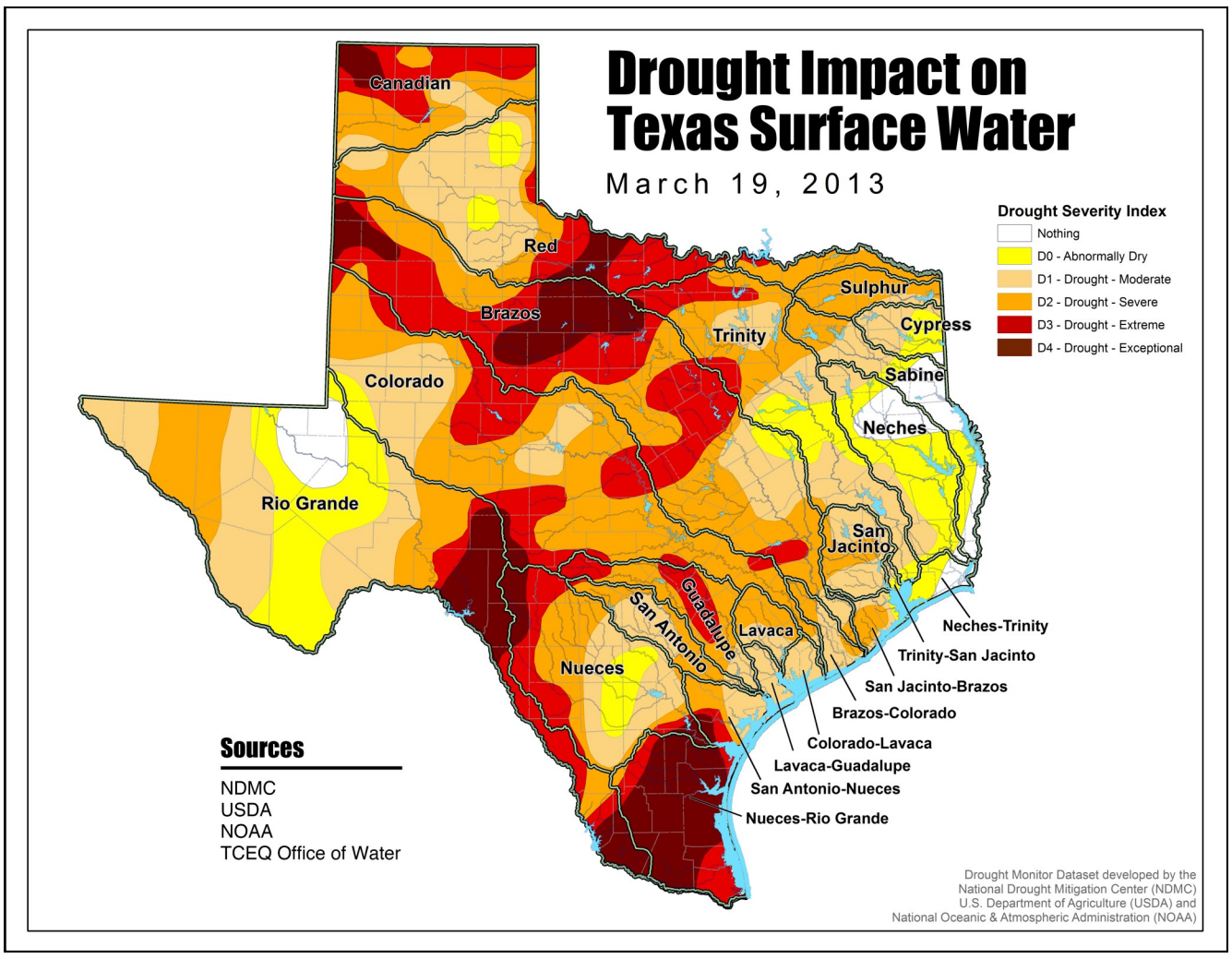
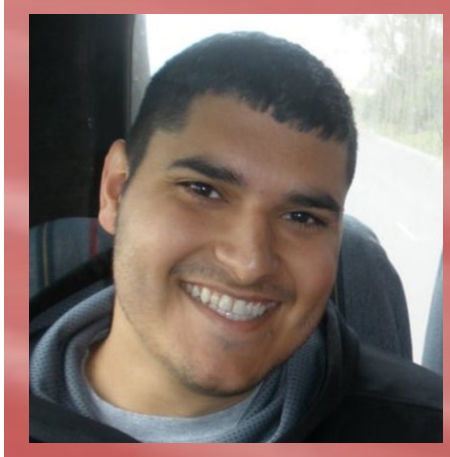


Photo Source: TCEQ

CONTRIBUTORS

Katharine Bradley is native to Dallas and a member of the Daughters of the Republic of Texas, the oldest patriotic women's organization in Texas—comprised of relatives of those who lived in Texas during its brief time as an independent nation. She received her undergraduate degree in Wildlife Ecology and Conservation from the University of Florida in Gainesville. She then served from January 2009 through March 2011 as a Peace Corps Volunteer in the rural community of Aldea Chiabal, Todos Santos Cuchumatán, Huehuetenango, Guatemala, Central America. She started her Master of Water Management at Texas A&M in August of 2011, and focused her studies on water resource management and solutions to socioeconomic water issues in developing countries.



Victor Garcia Jr. is originally from San Ygnacio, Texas. He holds a Bachelor of Science degree in Environmental Geosciences and a Geography minor from Texas A&M University. His research interests include water law, policy and conservation. He is a graduate research assistant under Dr. Kaiser and anticipates graduating in fall 2013.

Ray Kamps is a long-time Aggie. He got both his bachelor's and master's degrees from the department of Wildlife and Fisheries Sciences, and is working on his Ph.D. degree in the water program. His research interests include Environmental Physics, Eddy Covariance, Dendroclimatology, Limnology, Water Law, and Aquaculture. In his pastime, Ray enjoys SCUBA diving and looks forward to getting his Master Diver's certificate soon!

day because it is overwhelmed by photosynthesis, and therefore must be modeled during the daytime. This and the related water and energy flux calculations give a picture of photosynthesis and water usage in the wooded area as a whole.

The second tool, dendroclimatology (tree-ring analysis), is the classic method for determining a species' response to environmental variation. On an annual basis, rainfall tends to be the dominant factor causing variation in tree ring widths. But some factors (e.g. insect attack, tree age factor, tip growth and reproduction) affect the growth of tree rings. Excessive insect attacks tend to be sporadic. Tree-age factors are progressive and systematic, and can be modeled out to give a relatively pure rainfall-response. Some other factors are more difficult to model out, such as diverting carbon and water into storage carbohydrates, tip growth and reproduction instead of radial growth. Luckily, they can be collectively captured by the eddy covariance methodology. These two methods (eddy covariance and dendroclimatology) complete each other to some extent, and can be used together to give us a good estimate about how tree growth is affected by annual rainfall patterns.

Ray hypothesized that a very severe drought (i.e. 2008 and 2011) will hurt the Juniper more while lighter droughts (or simply "below average rainfall" years) give the disadvantage to the Plateau Live Oak. This is because a Live Oak that is starving can simply fail to set out seeds, or fail to grow any in that year, but will still be alive as long as it has water. During lesser droughts, this disadvantages Live Oaks. To the contrary, a Juniper that is dehydrated past a species-specific threshold will die, and this would happen in a massive scale during severe droughts.

On a continental scale, this research will be useful in understanding the water and carbon budgets of area when it is added to the Ameriflux database. The Ameriflux database contains continuous observations of ecosystem level exchanges of CO2, water, energy and momentum spanning diurnal, synoptic, seasonal, and interannual time scales and is currently composed of sites from North America, Central America, and South America. On a landowner scale, landowners in general have assumed that the Junipers were surviving by tapping into aquifer water and dropping aquifer levels. Millions of dollars have been spent in brush removal based on this misunderstanding. Ray's research together with others can help dispel it. These plants simply have strategies to survive droughts rather than avoid droughts by sipping aquifer water. The Edwards Aquifer in this area is about 60 meters deep and essentially out of reach for these two species. On the personal interest scale, Ray is most interested in understanding how carbon and water dynamics affect interspecies competition, which can lead to the change of landscape in a large temporal scale.

SOFT WATER

Water Gal

By Katharine Bradley

Disabled water faucet.

I developed a love for nature and ecology, I believe, from the deprivation of all things wild, which is prevalent in sprawling Texas suburbia as well as from being fortunate enough to be exposed to national parks across the United States throughout my childhood. The choice to study my bachelor's in Wildlife Ecology and Conservation at the University of Florida was exactly what I had envisioned it would be and I thoroughly enjoyed my course load that included camping, trapping and tagging animals, birding, hiking, species collections, electro-shock fishing, and a profound appreciation for the natural world in all its majesty. Needless to say many of my colleagues (and professors) would be happier in the middle of a forest, isolated from their own species and living as one with nature.

I joined the Peace Corps in what could either be considered a moment of clarity or insanity. This decision would ultimately lead me to become a 'water gal' as Dr. Kaiser would say here at Texas A&M. During the first year of my 2 years in the highlands of rural Guatemala officially serving as a "sustainable community tourism" volunteer, the 1,500-person community's delicate political balance shifted and I realized how complex and interdisciplinary water issues can become.

Just to paint the scene a bit, no household had running water. But, the community did have access to piped running water from a nearby spring that was constructed in the 1990's. The water was connected to faucets that were built in what can best be described as roughly every few blocks. Neighbors would connect hoses to the nearby faucet and fill troughs and water basins up for use later on in the day or week. The water would only run a couple hours a day, and people would share this time amongst themselves. There was no written code for water order, but it was understood when it was acceptable to remove someone else's hose or not.

In brief, this community has a history of being politically divided since the over 30-year civil war, or conflict period-as it is roughly translated - that officially ended in 1992. The rift in this community is between those who supported the government, and subsequent support of the genocide of Mayan communities, and those who supported the communistic guerrilla movement, that were incapable of protecting communities from the government forces.

This community has remained more or less divided along these historical ties, and small-town political tensions just so happened to come to a head while I was living there. Several riots broke out, involving 500+ people marching along with police in full riot gear and semi-automatic rifles across the countryside. The mob moved throughout the community and disabled or ripped out every faucet near people that supported the opposing side's political stance. My landlord was not in the mob, he along with most of those supporting the opposing side, either left town, went up on top of the mountain or locked themselves in their homes. I stood outside my house and watched. The people in the mob I knew waved, smiled and calmly chatted with me as the passed—it was surreal. Afterwards half the town, myself included, no longer had access to running water. That is the moment I became a water gal.

The Water Program here at Texas A&M has allowed me to really jump into the complexity of global water issues from various viewpoints. Engineering, ecological, social and political issues converge and can form an ugly mess of our water resources. Creative and interdisciplinary water professionals that understand appreciate the complicated nature of the problems will lead to better and more adaptable solutions to the current and future issues that face water resource management.

Water Conservation Research Group: What exactly do we do?

By Victor Garcia, Jr.

It is no question that Texas' water resources are becoming more stressed as our population grows and drought events, such as the one we are currently in, continue to occur. One great source of water to look into would be the water we already have. This of course refers to water conservation, one of the greatest untapped water supplies. Historically it has been underutilized, usually only taken in times of drought or emergency, but this has only recently begun to change. However, water utility companies are facing issues in trying to instigate these social changes in their customers' water consumption practices in the face of these conditions.

Looking around the country, it is clear that many cities have instituted successful conservation programs. The city of Albuquerque, NM has decreased per capita demands by 20% since the mid-1990s. New York City has saved 250 million gallons per day through an aggressive fixture replacement program. Seattle, WA has reduced its per capita demand by 20% over the past decade and has a goal of continuing to reduce demand by 1% annually. Right here in Texas, we have a model for conservation in the city of San Antonio, which has decreased its per capita use by 42%, despite being one of the fastest-growing cities in the nation. However, not all cities are the same, and it is crucial that each conservation program is adapted specifically to meet the needs of the city.

In order to address its increasing concerns with water supply, the city of College Station began to study the domestic outdoor water use of its customers. Focus was put on outdoor water use because indoor water use is much more difficult to change and would be less impactful. They called upon Dr. Kaiser for aid in implementation of their new conservation program. Within Dr. Kaiser's water conservation research group, Alan Lewis, Jennifer Nations, James Totten, Prakash Khedun, Adam Landon, and myself are looking into best management practices for water conservation in order to see what programs fit in and work best for the city of College Station.

Current state of the group study

Research data for this longitudinal study goes back to 2006. From 2009 to 2011, College Station residents in the top 10% (totaling approx. 2000 residences) of water usage were separated into four different groups:

1. Control group
2. Group which was informed of its position in top 10% and nothing further
3. Group which was informed of its position in top 10% and offered data about self-auditing
4. Group which was informed of its position in top 10% and offered an audit by the city

In 2012, the research group tweaked the grouping of the top users (roughly 5000 residences this time); separating them by the neighborhood they reside in. Water budgets for the years 2009 -2011 were accompanied with their actual usage in order to allow residents to see how their usage was in relation to what they "should" use. The water budgets were calculated using PET and giving generous leniency to the residents to water their St. Augustine grass. In addition, information was given to the residents showing them how their water usage compared to their neighbors.

In late 2012, surveys were sent out to each of the approx. 5000 residents so that we could better understand what the residents felt was most important, most confusing, most helpful, etc. from the data we were offering them. Using this survey data, the College Station conservation program can be further tailored to meet the needs of the city.

Most recently, our research group has begun to look into different questions in reference to the data, including:

- What were the impacts of the water budgets?
- How much overwatering did residents commit?
- What changes to watering practices occurred due to historic 2011 drought?
- How does water use vary by lot size and irrigation efficiency?

Additionally, this summer the research group has suggested the utilization of the local news to broadcast the atmospheric conditions and tell residents whether watering will be necessary on a week-to-week basis.

At the moment, each of our group members is working diligently on data accumulation and analysis. In the future, expect the results of our analyses to be shared at conferences, in papers, and of course in our program newsletter. Stay tuned for these exciting results!

Behind-the-Scenes at Aggieland's Largest Swimming Pool

By Alan Lewis

Anyone who has ever owned or maintained a private swimming pool knows the challenges involved in cleaning, balancing the chemicals, and changing the filters. Scale that up to an Olympic-size swimming pool, the largest standard-sized swimming pool, and you have the Texas A&M Natatorium. You may not often think about it, but the Natatorium is a prime example of recreation-oriented water management.

All told, the facility consists of seven water bodies, including the 50-Meter Pool, Dive Pool, Instructional Pool, Cain Outdoor Pool, and three hot tubs. At 822,000 gallons, the 50-Meter Pool is an impressive operation. This year, the pressure was on as facility personnel prepared the facility to host the 2013 SEC Swimming and Diving Championships. Texas A&M has hosted the NCAA championships and numerous tournaments through the years, but image is every-

Source: Aggie Athletics

thing when you're the kid in the club.

For an event televised by ESPN, the best image shows with everything running smoothly and uninterrupted by technical difficulties. When the doors open, everyone walks in expecting the pool to be clean and ready for swimming. It is easy to take for granted the work that goes into maintaining seven chemically balanced pools and spas with over 2 million gallons of water.

Rec personnel must be vigilant while following protocol. "One minute everything will be fine and during your next walk-through an hour later you might find a leak that wasn't there before," says the Dan Sterling, the Pool Technician. "Most repairs are done behind the scenes and behind closed doors." Even head guards are trained to conduct walkthroughs and check the pH and chlorine levels.

Chlorine exposed to UV radiation in the presence of organic matter can form a disinfection by-product called trihalomethane, a known carcinogen. Knowing this, one might wonder if the pools are safe since they are all chlorinated. However, the Natatorium pools, and in fact every chlorinated household swimming pool, must be balanced with cyanuric acid. This chemical is used as a precursor to *N*-chlorinated cyaurates, which not only stabilize dissolved chlorine by preventing it from volatilizing in direct sunlight, but also act as the principal disinfectants and algaecides in pools.

Achieving the proper chemical balance requires careful precision to mitigate health hazards. If you have ever gone swimming in a chlorinated pool and accidentally tasted the water only to find that it tasted like salt, it may not be because the pool is salted. In a chlorinated pool, a salty flavor generally indicates a high TDS, meaning that it is probably time for a partial or full water replacement.

The pools are scheduled for full water replacement every 2 years, generally during the summer when the patron usage is the lowest. Source water, which comes from the Carrizo-Wilcox Aquifer, has a high alkalinity and pH, making it difficult to balance. For the 50-Meter Pool, this process of emptying, refilling, and chemical balancing requires 8-10 days.

Water turnover rates are an especially important part of maintaining an Olympics-size swimming pool. With a filter rate of 7.57 gallons per minute (gpm), 37% of the water will be filtered during the first turnover, 86% during the second, 95% during the third, and so on. With a flow rate of about 2,285 gpm and each turnover lasting 6 hours, virtually all of the water will be filtered within a day.

For the people who maintain the Natatorium, each day brings forth exciting challenges. For Sterling, who has overseen countless problems resolved and the replacement of pumps, pipe sections, chemical storage tanks, and beyond, effective communication and a working knowledge of the facility's specific mechanics is a necessity. "None of this is possible without the help from many people," he says. "It takes multiple people working together and communicating ideas and thoughts to make it all happen."

The Texas A&M Natatorium upholds its lofty reputation as a world-class aquatics facility. It is open to all Rec patrons and is available for tours by appointment.

WATER FOR FUN

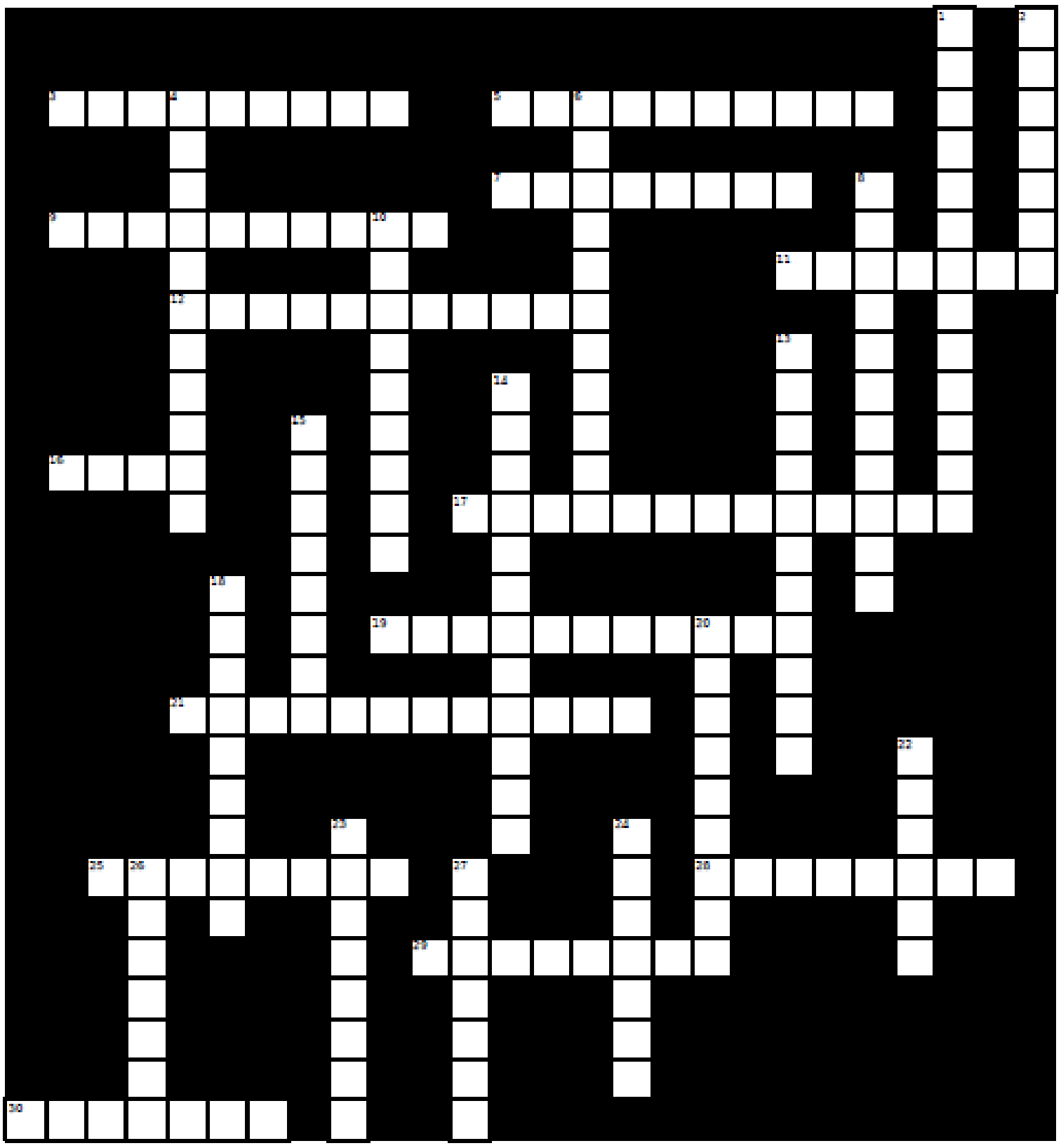
What's That Floating in the Water?

By Janet Torres

WATER MANAGEMENT & HYDROLOGICAL SCIENCE
TEXAS A&M UNIVERSITY

Groundwater Words

Crossword Puzzle by Peter Min-cheng Tu



[Click here for the Solutions]

Across

3 the soil's ability to attenuate substances which includes retaining chemicals or dissolved substances on the soil particle surface, transforming chemicals through microbial biological processing, retarding movement, as well as capturing solid particles
5 a type of monitoring well that is open only at the top and bottom of its casing
7 a liquid formed by water percolating through soil or soluble waste as in a landfill
9 the contour of the land surface
11 an accumulation of earth and stones carried by a glacier and usually deposited into a high point like a ridge
12 the water below the water table contained in void spaces
16 a vertical bore hole in which a pipe-like structure is inserted into the ground in order to discharge (pump) water from an aquifer
17 the process by which plants take up water through their roots and then give off water vapor through their leaves (open stomata)
19 the soil's ability to lessen the amount of, or reduce the severity of groundwater contamination
21 the property or capacity of a soil or rock for transmitting a fluid, usually wate
25 the sustained flow (amount of water) in a stream that comes from groundwater discharge or seepage
28 the natural process by which water transports salts and other soluble materials through the soil
29 water that is intercepted by vegetation and then runs down plant stems or tree trunks to the soil surface
30 solid or fractured rock usually underlying unconsolidated geologic materials

Down

1 deposition of rain, snow, sleet, dew, frost, fog, or hail
2 water safe for drinking
4 water that is intercepted by vegetation and then drips off it to reach the soil surface
6 the process by which water or other liquids change from liquids to a gas vapor
8 the actual movement of subsurface water either horizontally or vertically
10 the study of the occurrence, distribution, and chemistry of all waters of the earth
13 any substance that makes water unfit for a given use
14 the study of the interrelationships of geologic materials and processes with water, especially groundwater
15 sediments consisting of silt, sand, clay, and gravel in varying proportions that are deposited by flowing water in marshes or valleys
18 the land area from which surface water and groundwater drains into a stream system
20 water that travels laterally or horizontally through the zone of aeration (vadose zone) during or immediately after a precipitation event and discharges into a stream or other body of water
22 a natural discharge of groundwater at the land's surface
23 the ratio of the volume of void or air spaces in a rock or sediment to the total volume of the rock or sediment
24 the study of science dealing with the origin, history, materials and structure of the earth, together with the forces and process operating to produce change within and on the earth
26 a saturated geologic formation (rock or sediment) capable of storing, transmitting and yielding reasonable amounts of groundwater to wells and springs
27 a chemical formed when nitrogen from ammonia (NH3), ammonium (NH4) and other nitrogen sources combines with oxygenated water