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Oklahoma Water News

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Orbiting Satellite Watches Over Water Quality in State Lakes

Innovation uses LANDSAT to predict water quality

Monitoring the water quality of one lake is difficult, but keeping tabs on hundreds of wind-swept Oklahoma lakes can be an enormous job. Fortunately, now there may be a way to accomplish this monumental task by using global satellite technology in a unique water quality assessment technique developed by an OWRB researcher.

Oklahoma lakes exhibit many unique, and often detrimental, qualities. Soil loosened by construction and agricultural activities combines with brisk winds to erode the land surface and contribute tons of sediment to state lakes. These sediments boost the waters' turbidity and frequently contain nutrients and other harmful residues from man's activities in the watershed. They accelerate a lake's natural aging process, decreasing a reservoir's water holding capacity and spawning algal blooms which create oxygen deficiencies. This tragic process is called eutrophication and it threatens to destroy many Oklahoma lakes—and the life in them.

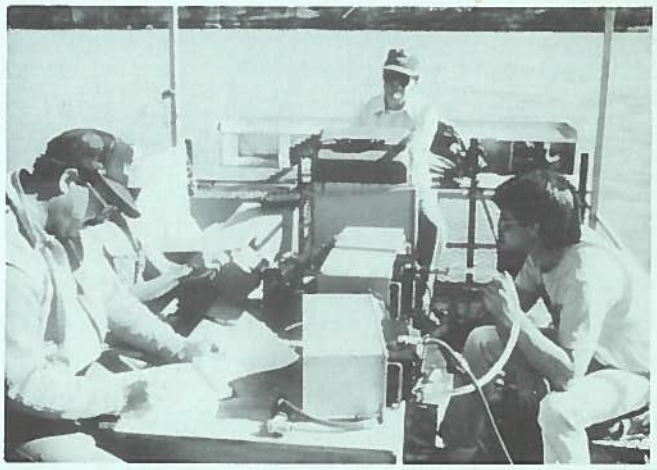
For years, limnologists have sought ways to curb eutrophication through development of reservoir monitoring and restoration techniques. Jim Grimshaw, environmental specialist and coordinator of the OWRB's Clean Lakes Program, may have solved this problem through the use of an innovative mapping procedure and the natural resource monitoring satellite, LANDSAT.

Through his work on several Phase I Clean Lakes projects, Grimshaw discovered an effective way to gauge a lake's condition. He found that by spatially measuring the chlorophyll content of a reservoir, he could generate a numerical "chlorophyll map" from the resulting data.

Chlorophyll is created during the photosynthetic process of plants—including algae. Excessive chlorophyll levels signal active algal production and deteriorating water quality.

In an effort to increase data accuracy, Grimshaw combined chlorophyll mapping in the field with LANDSAT remote sensing. He used a laboratory chlorophyll measuring device employed in previous mapping efforts, a spectrophotometer, to calibrate another instrument able to gather chlor-

Continued on page 2



Researchers running one of many chlorophyll mapping transects across Lake Thunderbird in Norman. OWRB's Jim Grimshaw (left) records water quality data while Sherwood McIntyre (center), of USDA's Watershed and Water Quality Research Lab in Durant, holds the pontoon's course. Lake water is pumped through two fluorometers which measure turbidity and chlorophyll via a subsurface probe. Hydrolab measurements are also taken by USDA's Mutsuo Yamamoto (seated next to Grimshaw) while Chris Armstrong (right), Oklahoma City-County Health Department, monitors fluorometric readings.

Satellite, continued from page 1

ophyll data in the field, a fluorometer.

"For collecting numerical data on water quality, we found that LANDSAT works best at assessing chlorophyll content and turbidity of reservoirs. Therefore, we decided to combine chlorophyll mapping techniques developed earlier with LANDSAT's numerical data gathering capabilities to get a more comprehensive picture of chlorophyll content," said Grimshaw.

In 1972, NASA launched its first earth-orbital satellite (originally named Earth Resources Technology Satellite) designed specifically for identifying and monitoring natural and man-induced variations in earth surface resources. Other launchings followed; the program was renamed, and the federal government turned LANDSAT over to private enterprise.

Standing about 10 feet tall and weighing more than one ton, LANDSAT satellites orbit the earth 14 times daily at an altitude of 570 miles. They take measurements in 115-mile-wide swaths, offsetting their orbit a little each day so they repeat coverage of the same geographic area every 18 days. From LANDSAT digital data, images, similar to photographs, are created.

LANDSAT's sensors, called multispectral scanners, record reflected solar energy—much like a light meter—over multiple portions of the light spectrum. On the earth's surface, various ground covers absorb and reflect different intensities of light, according to Grimshaw.

"In LANDSAT images, for example, sensors 'see' a forested area in a much darker tone than a desert area devoid of trees. For reservoir monitoring purposes, turbid or algae-infested water shows up much lighter than clear water, which is dark," he said.

In a 1979 study, Grimshaw used LANDSAT to gain a representative sample of statewide chlorophyll levels. He analyzed chlorophyll content in nine Oklahoma reservoirs from all geographic regions. Spectrophotometric chlorophyll measurements were made concurrently with satellite flyovers so correlations could be made between LANDSAT sensor reflectance values and chlorophyll readings. He then calibrated LANDSAT measurements to make its sensor readings consistent with Oklahoma's typical lake chlorophyll content. As a result, LANDSAT sensors were able to generate data capable of predicting chlorophyll levels for selected lakes.

"Results of that study showed promise, but we had one major problem," Grimshaw admitted. "LANDSAT gathers data spatially from a large area; our chlorophyll measurements were taken from point samples. Therefore, we had to discover a method of increasing spatial resolution over the reservoir so we could decrease the margin of error we were experiencing."

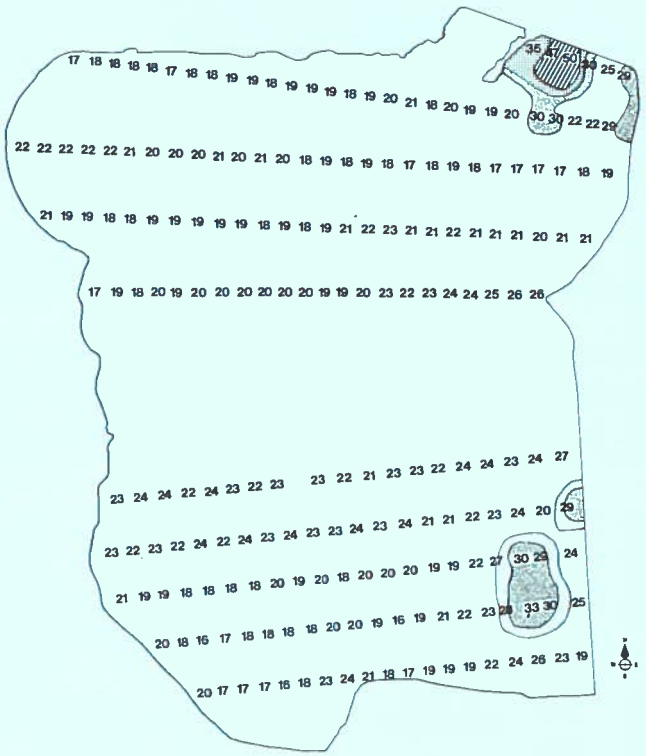
Out of necessity, Grimshaw developed a 'ground-truthing' calibration method termed 'serial' chlorophyll mapping. Because chlorophyll levels fluctuate often, mapping was done consecutively over many days. This allowed Grimshaw to pinpoint problem areas which contained persistently high amounts of chlorophyll.

"Serial chlorophyll mapping has already been proven effective in pinpointing sources of pollution and the extent of their impact. For example, we can easily identify lake areas high in chlorophyll and, by following the slope of the land, trace the nutrient loading to its source in the watershed—whether it be a broken sewage line or an overfertilized field. Watershed management is a key to controlling lake eutrophication," he said.

"The use of LANDSAT is not a substitute for traditional limnological techniques—it complements those methods with a minimum of field work. And although serial chlorophyll mapping has yet to be perfected, its potential is enormous," Grimshaw pointed out.

"We've really just tapped the surface of this technology," he added. "Soon we hope to combine serial chlorophyll mapping techniques and LANDSAT sensing with other innovative methods to assist in the prediction of many lake water quality parameters—not just chlorophyll. But we must reduce error to a minimum for future methodologies to be reliable."

"Our ultimate goal is to take a close look at the progress or decline of Oklahoma lakes over many years. This would tell us if controls are working or alert us when a reservoir is in trouble. Then, we could respond more efficiently with restoration procedures and perhaps even save the life of a dying lake," he said.



A typical chlorophyll distribution map of Overholser Reservoir. Numerals represent estimated chlorophyll readings in micrograms per liter. Shading intensities indicate chlorophyll "hot spots."

mainstream

EPA Asks Pesticide Strategy

In response to pressure to protect the nation's aquifers from contamination by pesticides, the U.S. Environmental Protection Agency has proposed a strategy to safeguard groundwater sources.

The plan focuses on preventing unacceptable levels of contamination, restricting pesticide use in vulnerable areas, and banning them once they exceed prescribed limits. It targets prevention of contamination as its national goal. According to the April issue of *U.S. Water News*, EPA proposes that each state design its own strategy.

Determination of unacceptable levels would depend on the use and value of the water resource, among other factors. For current or potential drinking water sources, acceptable contamination will be the maximum contaminant level for the pollutant as established by the Safe Drinking Water Act.

As detection levels increase, more stringent control measures will be taken. According to EPA, the strategy establishes a framework in which the states can tailor pesticide management measures to specific local groundwater protection needs.

Oklahoma Drillers Now OGWA

At their recent annual meeting in Oklahoma City, members of the Oklahoma Water Well Association voted to change the name of the organization to the Oklahoma Groundwater Association. OGWA is the professional organization of licensed water well drillers.

According to Robert Hall, OGWA executive secretary, 404,774 Oklahomans—or 13.3 percent of the population—use private water wells as their primary source of water. Additionally, of the 10 largest cities, five rely partially or entirely on groundwater. These five cities have a combined population of 606,000—or 20 percent of the state's total population.

More than a million people—or roughly one-third of the state's citizens—rely on groundwater for drinking water.

Oklahoma County has the largest number of wells with 18,744.

New Process Removes PCBs

A new trademarked process to remove polychlorinated biphenyls from industrial sludge has been successfully tested in a Superfund cleanup at a PCB-contaminated refinery site in Georgia.

According to the May issue of "*U.S. Water News*," the process uses a unique solvent (triethylamine) which separates sludge into water, oil and solid residue. Moreover, at temperatures around 40 degrees Fahrenheit, it dissolves both oil and water; at 65 degrees F. it dissolves only oil. It is this change in solvent characteristic that makes the process unique.

At the Georgia site, the system recycled 100 tons of sludge a day at a cost of $160 a ton. The company that holds the patent says it can transport a 100-ton-per-day unit to any hazardous waste site. Looking ahead, the company sees great market potential in cleaning up PCB-contaminated harbors.

Who Did In the Dinosaurs?

The publication of a new study by a researcher at Scripps Institution of Oceanography in La Jolla rekindles the theory that prehistoric dinosaurs may have been exterminated by acid rain.

Scripps geochemist J. Douglas Macdougall claims acid rain as corrosive as battery acid leached strontium-87 from rocks and washed it into the sea. The discovery of strontium-87 in tiny sea fossils is convincing evidence, he claims. Macdougall says levels were highest during the mass extinctions of 65 million, 94 million and 225 million years ago. He suggests the acid rain could have been set off by a huge meteorite striking the earth.

It's a tantalizing piece of evidence for the "huge acid rain event" say some scientists. Others question why it was just the dinosaurs who succumbed, leaving fish, lizards, amphibians, snakes, crocodiles, birds and turtles intact.

Infrastructure is Fragile

"Fragile Foundations: A Report on America's Public Works," a report on the findings of a study commissioned by the Congress in 1984, was released recently with bad news for the nation. The National Council on Public Works Improvement warned that the failing infrastructure will jeopardize the productivity of our economy and our quality of life.

The report makes nine recommendations for meeting demands of future economic growth and development:

- a national commitment to increase capital spending 100% at all levels;
- clarification of the roles and responsibilities of federal, state and local governments in public works construction and management;
- more flexible administration of federal and state mandates to allow cost-effective compliance;
- accelerated spending of federal highway, transit, aviation and waterways trust funds;
- shouldering of a larger share of public works costs by those who benefit from the services;
- removal of limits on the ability of state and local governments to help themselves through tax-exempt financing;
- greater incentives for the use of demand management, coordinated land-use planning and waste reduction and recycling;
- more support for technological innovation and for the training of public works professionals;
- a rational capital budgeting process at all levels of government.

Young Scientists Recognized

Two junior high school students were recognized by the OWRB for their outstanding research at the annual state meeting of the Oklahoma Junior Academy of Science (OJAS), April 1 and 2.

The science research contest—held concurrently with the Oklahoma Junior and Senior High School State Science Fair at East Central State University in Ada—was the culmination of 11 regional contests where 325 students

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competed for the top two research papers in physics and biological sciences. Eighty-one young scientists presented their papers during the contest finals.

"We hope the awards will start future Nobel Prize winners on their way," said Jimmie Pigg, OJAS Director.

Ann Moore, Ponca City East Junior High School, received the recognition for outstanding research in natural resources for "Abrasiveness of Toothpaste." Muskogee student Hoyt Sizemore, Alice Robertson Junior High School, brought home the award in the water conservation category for "Design and Construction of a Solar Thermosiphon Water Heater."

Certificates, courtesy of the Oklahoma Water Resources Board, were presented to both winners.

ACTIVE CONSERVATION STORAGE IN SELECTED OKLAHOMA LAKES AND RESERVOIRS AS OF APRIL 22, 1988

PLANNING REGION LAKE/RESERVOIR	CONSERVATION STORAGE (AF)	PERCENT OF CAPACITY
SOUTHEAST		
Atoka	123,475	100.0
Broken Bow	918,100	100.0
Pine Creek	77,700	100.0
Hugo	157,600	100.0
McGee Creek		——[1]
CENTRAL		
Thunderbird	105,925	100.0
Hefner	75,355	100.0
Overholser	10,082	63.3
Draper	76,870	76.9
Arcadia	27,330	99.8
SOUTH CENTRAL		
Arbuckle	62,571	100.0
Texoma	2,637,700	100.0
Waurika	203,100	100.0
SOUTHWEST		
Altus	132,457	99.7
Fort Cobb	78,217	99.7
Foss	159,890	65.6[2]
Tom Steed	88,971	100.0
EAST CENTRAL		
Eufaula	2,329,700	100.0
Tenkiller	627,500	100.0
Wister	27,100	100.0
Sardis	302,500	100.0
NORTHEAST		
Eucha	79,567	100.0
Grand	1,491,800	100.0
Oologah	544,240	100.0
Hulah	30,594	100.0
Fort Gibson	365,200	100.0
Heyburn	6,600	100.0
Birch	19,200	100.0
Hudson	200,300	100.0
Spavinaw	30,000	100.0
Copan	43,400	100.0
Skiatook	319,400	100.0
NORTH CENTRAL		
Kaw	428,600	100.0
Keystone	616,000	100.0
NORTHWEST		
Canton	97,500	100.0
Optima	3,000	——[1]
Fort Supply	13,900	100.0
Great Salt Plains	31,400	100.0
STATE TOTALS	**12,539,844**	**99.3[3]**

1. In initial filling stage
2. Temporarily lowered for maintenance
3. Conservation storage for Lake Optima not included in state total

Data courtesy of U.S. Army Corps of Engineers, Bureau of Reclamation, Oklahoma City Water Resources Department, and City of Tulsa Water Superintendent's Office.

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