Aquarius

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UWRL Project Profile

William J. Doucette, Utah Water Research Laboratory Associate Professor, and his research team developed a computer Property Estimation Program (PEP) that makes estimating the chemical-physical properties used in environmental fate modeling easier.

Environmental scientists and engineers often use mathematical models to estimate the fate and impact of organic chemicals in the environment. These models idealize the environment as a system of connected compartments (i.e., water, soil, sediment, air, and biota). The complexity of these models range from simple steady-state models, such as the Fugacity Level 1 Model to non-steady-state models which include transport between compartments, degradation processes, and the effect of environmental variables.

Many estimation methods exist for any chemical-physical property. The methods have widely varying results, and choosing the best results can be difficult for non-experts. In addition, relying on only one estimation method can result in large errors and unnecessarily large confidence intervals or the illusion of an improperly small prediction interval.

The models require parameters that describe the site and contaminant physical-chemical and biological characteristics. Aqueous solubility (S), octanol/water partition coefficient (K_{OW}), organic carbon normalized soil/water sorption coefficient (K_{OC}), vapor pressure (P_V), Henry's law constant (H), and bioconcentration factor (BCF) are the key properties for assessing mobility and distribution of chemicals in environmental systems.

Because few experimentally determined values of these properties exist, estimated values must often be used. Quantitative Property-Property Relationships (QPPRs) and Quantitative Structure-Property Relationships (QSPRs) are used to obtain these values. QPPRs are used to predict the property, based on the relationship between the two properties as determined by regression analysis. QSPRs are used to infer or calculate the chemical's properties from

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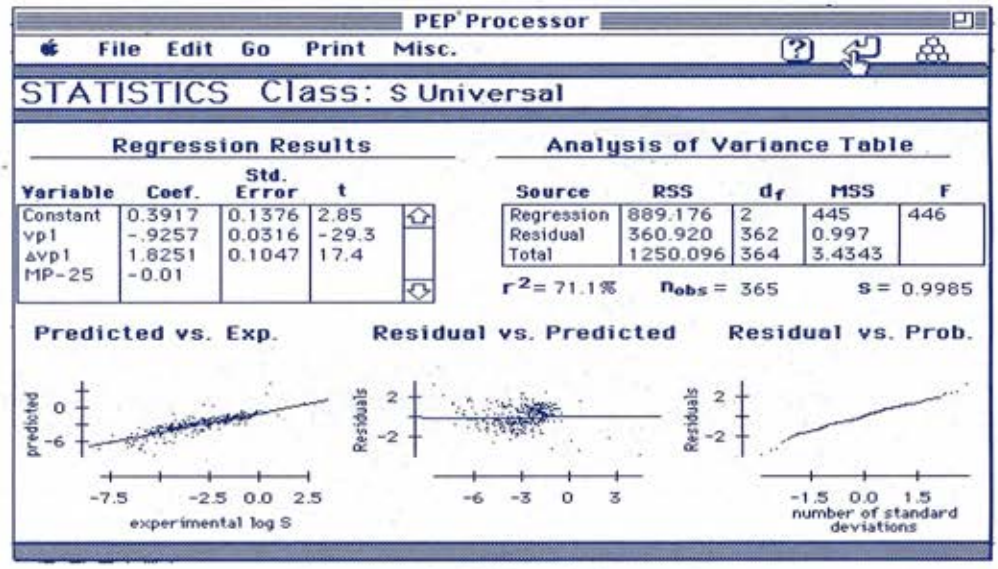

Example of a PEP statistics card

In this issue . . .

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the molecular structure. Often QSPRs are correlations between the property of interest and structurally derived parameters, such as molecular connectivity indices (MCIs) or total molecular surface area (TSA).

UWRL's computerized Property Estimation Program incorporates QPPRs and QSPRs into a property-estimation Hypercard for the Macintosh computer program. Easy to use, PEP has algorithms for calculating structural descriptors, statistical information on the development of QPPRs and QSPRs, and an indication of the accuracy of the estimated property.

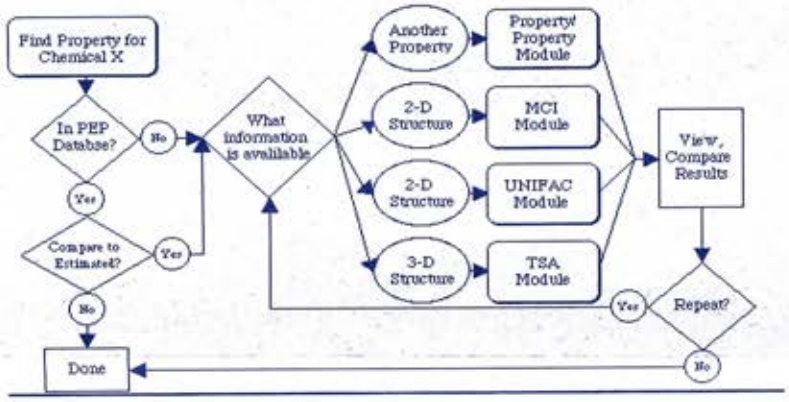
PEP uses (1) molecular connectivity indices-properties (MCI) correlations, (2) total molecular surface area-properties (TSA) correlations, (3) property-property correlations, and (4) UNIFAC-derived activity coefficients.

A chemical property database, containing experimental values of S, K_{OW}, H, P_V, K_{OC}, and BCF, compiled from a variety of literature sources and computerized databases was used for developing the MCI-property, TSA-property, and property-property relationships used in PEP. This database, which currently contains over 800 chemicals, is linked directly to PEP.

The property-estimation modules in PEP are also linked directly to the Level 1 and 2 Fugacity Models. The combination of the various property estimation methods, chemical property database, and simple environmental fate models provides users with a methodology for predicting the environmental distribution of an organic chemical in a multiphase system requiring only the structure of the chemical of interest as input.

PEP was developed with funding from the U.S. Air Force of Scientific Research, Bolling AFB, DC.

For more information on the project, contact William J. Doucette at (801) 750-3178.



Flow chart showing the operation of PEP

UWRL Research

Evaluation of Libby Superfund Site

UWRL investigators, led by Ronald C. Sims, continue to evaluate the Champion International Superfund Site in Libby, MT. They are investigating the effectiveness of the following biological treatments of contaminated soil and groundwater: (1) surface soil bioremediation in a lined, prepared-bed land and treatment unit; (2) oil-water separation of extracted groundwater after aqueous phase treatment in an above-ground, fixed-film bioreactors; and (3) in-situ bioremediation of an upper aquifer. The design, operational, monitoring, and performance activities of each treatment are being considered.

The study is part of the US EPA Bioremediation Field Initiative, and began in July 1991.

Annual Report

The 1992 Annual Report is now available. It contains reports of projects in progress from January 1, 1991 to June 30, 1992. Reports from the following Utah State University centers and departments are included:

- Utah Water Research Laboratory
- Utah Center for Water Resources Research
- Department of Civil and Environmental Engineering
- Department of Biological and Irrigation Engineering
- International Irrigation Center
- Cooperative Fisheries and Wildlife Research Unit
- Institute for National Systems Engineering

The Annual Report is divided into the following sections: Biological & Irrigation Engineering, Environmental Analysis, Fisheries, Geotechnical Engineering, Groundwater, Hydraulics & Fluid Mechanics, Hydrology, International Programs, Natural Systems Engineering, Resource Information Systems, Technology Transfer, Transportation, Waste Management, Water Information & Education, Water Quality, and Water Resources Planning & Management.

The report contains directors' reports, and a one- to two-page description of each active research project and all associated publications. A Summary Annual Report is also being prepared. It will contain short descriptions of the active research projects, along with a publications list.

Both the Summary Report and the Annual Report are available from Publications, Utah Water Research Laboratory, Utah State University, Logan, UT 84322-8200. There is no charge.

UWRL Faculty and Staff

Faculty Appointments and Retirements

☞ Dr. David S. Bowles replaced Dr. L. Douglas James as Director of UWRL and Utah Center for Water Resources Research (UCWRR). Dr. Bowles has served as associate UWRL director for the last six years. His expertise includes hydrology, hydrologic modeling, hydraulic and sediment transport modeling, dam safety evaluation, risk assessment, and geostatistic methods. He will divide his time between administrative responsibilities at the laboratory, and research and teaching in USU's Civil and Environmental Engineering (CEE) Department.

☞ Dr. J. Paul Tullis has been named Head of the UWRL Water Division, in addition to his continuing assignments as Adjunct Professor in the CEE department and a Senior Research Scientist at the USU Foundation.

☞ Dr. Grant (Gill) Smith has retired as director of the International Office for Water Education (IOWE). He expanded the Young Artist's Poster Contest, developed by Mr. Mardell Parrish to include a water education calendar that features winners of the poster contest each year. With financial assistance from the U.S. Geological Survey's National Water Information Clearinghouse (NWIC), a similar poster-calendar program was initiated during Gill's tenure in the other six western states served by the Colorado River.

Dr. Smith also obtained first-year funding under the Dwight D. Eisenhower Math and Science Education Act to teach workshops in Utah. His leadership in the IOWE will be greatly missed.

☞ Dr. C. Earl Israelsen succeeds Dr. Smith as IOWE director. Dr. Israelsen, CEE/UWRL professor, has been IOWE Associate Director since the program began. Among his many accomplishments, he and Dr. Donald Daugs co-authored the Water Education K-6 teacher's manual. They continue to collaborate on water education materials for elementary and secondary schools.

☞ Dr. William J. Doucette, Associate Professor, is on leave to serve as a Senior Environmental Chemist at Lilly Research Laboratory in Greenfield, Indiana. The laboratory is a division of Eli Lilly Company. Dr. Doucette is investigating the environmental fate of pharmaceuticals.

☞ Dr. William J. Grenney, Professor and former CEE Department Head, has just returned from sabbatical. For the last year, he was a Visiting Professor at the National Ecology Research Center in Fort Collins, Colorado. While there, he developed expert systems for evaluating the environmental impact that stream-flow alterations has on fisheries. He also conducted seminars to present his research results.

☞ Dr. Daniel H. Hoggan is currently on an intergovernmental Personnel Act appointment with the U.S. Army Corps of Engineers, Sacramento District, Hydraulics Design Section. His research includes one- and two-dimensional hydrodynamic modeling of flood flows with a digital terrain model, using a UNIX-based computer graphics system (Intergraph).

☞ Dr. Upmanu Lall, is on sabbatical this year. He is working in the Branch of System Analysis, Water Resources Division, National Research Center, USGS, Reston, VA.

Changes in UWRL Staff

☞ New additions to the Utah Water Research Laboratory staff included: Phyllis Bustamante, Library Assistant; Ken Jewkes, Shop Technician; and Shawna Johnson, Administrative Secretary.

☞ Departures included: Verl K. Bindrup, Senior Research Technician; Lorraine Kimber, Office Assistant IV; Linda Krywy, Research Technician I; Art L. Rivers, Senior Graphics Technician; and Connie Runnells, Executive Secretary.

Tribute to Dr. L. Douglas James

Dr. L. Douglas James completed his fifteen-year tenure as Director of the Utah Water Research Laboratory (UWRL) and the Utah Center for Water Resources Research (UCWRR) at the end of 1991. Dr. James served Utah State University, the State of Utah, and his profession tirelessly. Besides being UWRL and UCWRR Director, he has been a dedicated teacher, a productive researcher, and an unselfish participant in state and national organizations.

Dr. James directed his keen intellect and endless energy to many Utah water problems ranging from Great Salt Lake flooding to water conservation, and from the State Water Plan Coordinating committee to the State Advisory Council on Science and Technology. In 1991, he was awarded the Governor's Medal for Science and Technology.

Dr. James' book, Economics of Water Resources Planning, published by McGraw-Hill in 1971, is recognized throughout the world as a standard text in the water resources field. He has served on numerous professional committees, a Presidential Panel on Review of Federal Dam Safety, and the Water Science and Technology Board of the National Academy of Science. Also, he played a lead role in the formation of the American Institute of Hydrology, a national organization for certifying professional hydrologists. Currently he serves as its president.

Dr. James will spend the next two years as Program Director for the new National Science Foundation program in hydrology. We wish him well in this new assignment and look forward to his return to the UWRL.

AGU Paper Presentations

American Geophysical Union Fall Meeting in San Francisco, CA, December 1992 (Abstracts in EOS Transactions 73(43), October 27, 1992). For more information on the presentations, contact the authors directly.

Chowdhury, T. G., D. G. Tarboton, and D. S. Bowles. An energy balance snowmelt model for erosion prediction.

Goodrich, D. C., T. J. Schmugge, and T. J. Jackson. Runoff simulation sensitivity to remotely sensed soil water content at the medium catchment scale.

Grenney, W. J., J. P. Riley, and R. A. Young. Cost allocation for the Nile River water supply system in Egypt.

Gunderson, R. W., J. P. Riley, and A. K. Sikka. An interactive graphics fuzzy clustering procedure for partitioning a watershed into hydrologic response units.

Humes, K. S., W. P. Kustas, and T. J. Jackson. Combined use of visible, near-infrared, thermal and passive microwave remote sensing observations over a semi-arid watershed.

Jackson, T. J., G. C. Heathman, F. R. Schiebe, E. T. Engman, M. S. Jasinki, and D. E. Le Vin. Washita '92 soil moisture observations.

Kaluarachchi, J. J., and K. M. Islam. Modeling of thermal venting to remediate hydrocarbon contaminated soils. Poster session.

Kemblowski, M. W., and C. M. Chang. The impact of the statistics of unsaturated flow parameters on effective macroparameters of flow and solute transport.

Limaye, A., J. P. Riley, and A. K. Sikka. Use of a watershed modeling for estimating the impact of climate on droughts.

Ma, Y., G. Urroz, and M. W. Kemblowski. Kinematic mixing in stochastic velocity fields.

Morshed, J., and J. J. Kaluarachchi. Time-lag error of operator splitting technique in solving the convective-dispersive-reaction equation.

Rajagopalan, B., A. K. Sikka, and D. S. Bowles. Drought analysis using nonparametric wet/dry spell model.

Riley, J. P., G. E. Bingham, R. W. Gunderson, R. Hansen, D. T. Jensen, A. Limaya, and A. K. Sikka. Application of a distributed parameter watershed model for estimating the effects of climate change on the hydrologic response of a mountain watershed.

Sikka, A. K., A. S. Limaye, and J. P. Riley. Development of a distributed parameter watershed model for predicting the hydrologic response of vegetated mountain watersheds.

Wen, J. C., and M. W. Kemblowski. Role of plume characteristic scale in the solute spreading process.

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TECHNOLOGY & INFORMATION TRANSFER

Workshops & Conferences

Bioremediation Workshop

For many years, hazardous waste has been dumped into our nation's soil and ground water. The private sector, government, and academia are now evaluating and monitoring waste sites to mitigate or eliminate the health and environmental risks posed by these wastes, and to comply with environmental laws.

Bioremediation is a technology that can be used to treat contaminants that are biodegradable, breaking them down into less toxic products. The success of the technology and its cost effectiveness depends on the interaction of site, soil, and waste conditions. Development of an understanding of the complex interrelationship of these conditions requires a broad background in various biological and physical sciences including biology, chemistry, physics, geology, and engineering. Since people cannot be experts in all these disciplines, they must learn to ask the right questions in order to make informed decisions about developing, evaluating, and selecting an appropriate bioremediation treatment technology.

The Utah Water Research Laboratory (UWRL) short course "Fundamentals of Bioremediation of Hazardous Waste Contaminated Soils" summarizes and applies soil fundamentals critical to understanding and managing hazardous materials to the design and evaluation of soil bioremediation systems. The course emphasizes applying fundamental chemical, physical, biological, and soil science principles to developing and implementing biological remediation strategies for CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) and RCRA (Resource Conservation and Recovery Act) regulated hazardous waste sites.

Through teaching this workshop, UWRL serves individuals in private industry, consulting, regulatory agencies, and academia involved in the development, evaluation, and selection of biological systems for the remediation of hazardous waste contaminated soils.

The workshop stresses the theoretical background of bioremediation treatment. Topics include soil chemical, physical, and biological process fundamentals; physical, chemical, and biological remediation techniques; transport and fate modeling; field sampling and measurement methodologies; and waste biotreatability studies. The instructors then address applications of this information to large-scale field experience through case studies and a field trip.

The workshop offers continuing education credits and is scheduled for August 30 through September 3, 1993 at Utah State University. For more information, call (801) 750-3693. •

In this issue . . .

We have adapted a new format that focuses on a single UWRL program. This edition summarizes the Techology and Information Transfer program, with sections on "Workshops and Conferences," "Manuals and Publications," "International Training," and "Water Education." In addition we are involved with USU students and academic programs. We are striving to continuously improve our technology and information transfer, and would appreciate your suggestions.

David S. Bowles, UWRL Director

Physical Habitat Simulation System Course

This September, Dr. Thomas B. Hardy (UWRL) will teach a 40-hour course on "Using the Computer-Based Physical Habitat Simulation System" (PHABSIM). The National Ecology Research Center developed PHABSIM to simulate the relationship between stream flow and physical habitat availability for various life stages of a species of fish. The objective of the simulation is to obtain a representation of the physical properties of a stream that can be related through biological considerations, to the social, political, and economic world.

The course will provide "hands-on" training in the use of the PHABSIM's library of computer programs. Activities are divided between lecture sessions and supervised exercises on the computer. The theory, calibration, and simulation of modeling open channel flow using several hydraulic models will be provided, as well as the use of several models for simulating available habitat for aquatic resources.

The course is for persons responsible for processing field data through PHABSIM system models, project leaders and others responsible for field measurements required of a complete stream habitat analysis, and those persons responsible for quality control or analyzing, interpreting, and defending the results of a study. The course is listed as IF310 with the US Fish and Wildlife Service Instream Flow Training Series.

The course will be taught September 20-24, 1993 at Utah State University. For information, call (303) 491-7767. •

Dam Rehabilitation Conference

In recent years, new dam construction has been limited in the United States, but major efforts are underway to rehabilitate existing dams. Many of these dam modifications have been initiated to satisfy new hydrologic or hydraulic criteria. However, almost all remedial work requires geotechnical investigations, design, and construction. The Geotechnical Practice in Dam Rehabilitation Conference last April addressed new developments and advances in all areas of geotechnical practice associated with the analysis, design, and performance of dam rehabilitation. This well-defined area of geotechnical practice is important to the geotechnical profession. Examples of pertinent subject areas in which significant advances have been made include dam safety assessment, site characterization techniques, stability and seepage analysis techniques, software development, seepage control, stabilization, spillway improvements, use of geosynthetics, and performance monitoring and instrumentation.

In addition, the conference sessions presented new procedures for improving seismic stability, including applications of geosynthetics and ground improvement techniques. Also, issues related to sudden drawdown analysis and risk and reliability assessment were discussed. The program featured invited papers by internationally recognized experts, presentations of selected submitted papers, a panel discussion, a poster session, and technical exhibits.

The Geotechnical Engineering Division of ASCE sponsored the specialty conference at North Carolina State University in Raleigh, NC. Dr. Loren R. Anderson (USU CEE Department Head) was on the organizing committee and was the editor of the conference proceedings. Dr. David S. Bowles (UWRL Director) presented a keynote paper on "Risk Assessment: A Tool for Dam Rehabilitation Decision." •

Hydraulics Short Courses

Last October, Dr. J. Paul Tullis (UWRL) presented a paper on the "Selection and Use of Control Devices in Water Distribution Networks" in Valencia, Spain. He was one of the lecturers at the international short course on "Water Supply Systems: State of the Art and Future Trends" coordinated by the Fluid Mechanics Group of Polytechnic University. Much of the information in the paper is also available in his 1989 book *Hydraulics of Pipelines: Pumps, Valves, Cavitation, and Transients*, published by Wiley and Sons, Inc.

In February, Dr. Tullis conducted a short course on air-operated valves for power plant engineers and maintenance personnel. Electric Power Research Institute (EPRI) Monitoring and Diagnostics Center (Eddingstone, PA) sponsored the course. Dr. Tullis and Steven L. Barfuss wrote the course book entitled *Valve Applications*.

Dr. Tullis has also conducted EPRI short courses on check valves for three years. He used the EPRI publication *Application Guidelines for Check Valves in Nuclear Power Plants* as the text for the courses. The course will be taught again next November at Utah State University. The course material is suitable for anyone dealing with control valve problems. Contact Dr. Tullis at (801) 750-3164 for more information. •

Pipe Network Simulation & Design Workshop

The USU Pipe Network Simulation and Design Workshop covers state-of-the-art methods for the analysis and cost-effective design of water distribution and other piping systems. Dr. Roland W. Jeppson (UWRL) has taught the annual workshop for the last ten years. The theory and practice of using computer solutions for analysis and design of looped and branched pipe networks are covered. The major emphasis is on the effective use of the USU-NETWK software package to enhance understanding and improve the design and performance of water distribution systems.

USU-NETWK began twenty years ago with a small Kellogg Foundation grant. At the time, computers were just starting to be used in solving engineering problems that were impractical to solve by other means. Dr. Jeppson developed an easy-to-use computer program that handles all the features associated with large looped networks. USU-NETWK has been used worldwide to solve many types of problems, including applications such as a simulator

Pipe Network Workshop continued
for training operators of large petroleum barges how to control pumps that unload the product and take sea water into the holding tanks. Dr. Jeppson has also enhanced USU-NETWK to provide time-dependent solutions, capability to size components most economically to satisfy desired requirements, and simultaneously do engineering economics of piping systems being hydraulically analyzed. •

Ground Water Short Course

Since 1988, Drs. Marian W. Kemblowski and Jagath Kaluarachchi (UWRL) and Dr. Jack C. Parker (Virginia Polytechnic Institute) have conducted short courses on "Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Use of Models for Site Assessment and Remediation." They have taught the fundamentals of numerical modeling of the fate and transport of hydrocarbons in the subsurface to consultants, federal agencies, oil company personnel, and other faculty. With computer modeling, the behavior of hydrocarbons can be analyzed with less expensive field investigation. •

Other Courses

UWRL faculty R. Ryan Dupont, Darwin L. Sorensen, Michael J. McFarland, and Soil Scientist Joan E. McLean teach regular and extension courses to Hill Air Force Base personnel. The topics include hazardous waste incineration, accident and emergency management, and environmental management and legislation. The CEE/UWRL Division of Environmental Engineering provides outreach classes to Utah's technical community including Hill Air Force Base personnel. •

Examples of other UWRL workshops & courses include:

- Aquatic Ecosystem Inventory Techniques (T. Hardy)
- RCRA Corrective Action Stabilization Technologies Seminar (R.C. Sims, et al.)
- Remediation of Contaminated Sites Workshop (R.C. Sims, et al.)
- Risk Assessment for Dam Safety (L.R. Anderson and D.S. Bowles)
- River Basin Planning (L.D. James)
- Transport and Fate of Contaminants in the Subsurface (R.C. Sims, et al.)
- Using HEC-2 and WSPRO to Compute Water Surface Profiles (D.H. Hoggan)

Manuals & Publications

UWRL produces many manuals and publications, contributing over a hundred publications to the National Institute of Water Resources Database each year. A catalog of all UWRL publications soon will be available from the UWRL Information Dissemination Group (801) 750-3181.

EPA Manuals

UWRL faculty members have prepared several manuals for the US Environmental Protection Agency. The *Permit Guidance Manual for Land Treatment of Hazardous Wastes* (EPA-530/SW86-032) discusses the initial design plan and operation of a hazardous waste land treatment site. *Hazardous Waste Land Treatment Closure/Post-Closure* (EPA Directive 9476.00-9) and its appendix, *Hazardous Waste Land Treatment Closure Plan Analysis*, describe how to close the site once the project is completed. •

Check Valve Guidelines

Professor J. Paul Tullis, head of the CEE/UWRL Water Division, has published many articles and books on the hydraulics of pipelines. He recently wrote *Cavitation Guide for Control Valves* for the Nuclear Regulatory Commission. Geared for nuclear power plant engineers and operators, valve companies, and architecture engineering firms, the guide discusses the fundamentals of cavitation and how to reduce the problems that it causes. Cavitation eats holes through valves and pipes, causing dangerous leaks and costly repairs.

Dr. Tullis is the major author of the update of *Application Guidelines for Check Valves in Nuclear Power Plants* that will be published in August by the Electric Power Research Institute (EPRI). •

Water Atlas of Utah Update

Over the last several years, the Utah Water Research Laboratory has been coordinating the assemblage of material for a new Water Atlas of Utah. Various federal and state agencies have provided information, including the State Climatologist, State Division of Water Resources, US Geological Survey, Utah Geological Survey, State Division of Water Rights, Bureau of Water Pollution Control, Utah Division of Wildlife Resources, Division of Parks and Recreation, and private contractors.

In 1968, the UWRL, in cooperation with the Utah Division of Water Rights, prepared and published the *Hydrologic Atlas of Utah*. The new Water Atlas project will update and expand the data and information contained in the earlier publication. The full-color book will be a useful resource for contractors and school children, as well as lay people. It will contain information on Utah's water history, climate, weather, topography, evaporation, water sources, water use, and water quality. •

International Training

Cost Allocation Training

Drs. J. Paul Riley and William J. Grenney of UWRL and Dr. John E. Keith of the USU Economics Department have provided technical assistance to the Organization for the Development and Management of the Senegal River (OMVS) for nearly twenty years. During that time, two major dams have been constructed in the Senegal River Basin, West Africa. Extensive planning for the distribution of water for energy, agriculture, and navigation has also taken place. The Senegal is one of the largest rivers in Africa. It rises in the north of Guinea, crosses the western part of Mali, and then, for the rest of its course to the Atlantic Ocean, forms the border between Mauritania and Senegal. The three basin countries, Senegal, Mauritania, and Mali make up the OMVS.

USU's technical assistance to the OMVS includes a training component. For example, 14 African water resource experts and government officials attended a 50-day training session at USU last October and November. The training included both technical and institutional aspects of allocating water resources in the Senegal River Basin. The classes were eight hours a day, with 50% of the time devoted to classroom activities, and 50% to laboratory and problem-solving sessions. In the computer laboratory sessions, participants used computer programs developed by the USU team for fiscal allocation studies.

As a follow-up to the training, the investigators traveled to Senegal to implement the cost allocation model on OMVS computers and to finalize their recommendations for allocating the cost of the two projects. The USU team makes recommendations to OMVS on how to divide repayment of the construction loans and on the system operating and maintenance costs between the participating countries according to the benefits derived by each country from the project. •

Training of Indian Trainers

In April 1993, UWRL faculty conducted a Training of Trainers (TOT) program for four faculty members from the Central Training Unit (CTU) for Integrated River Basin Planning and Management in Pune, India. UWRL collaborated with Harza Engineering Company to establish the CTU between 1987 and 1991. Some two hundred engineers from across India have now received intensive training through introductory (four-month) or advanced (ten-month) programs, and have returned to their home states to work on river basin planning.

The TOT program was comprised of a week at Harza's Chicago headquarters and two weeks at USU. The Harza component focused on strengthening the river basin planning case study used in the CTU advanced training program.

USU trainers reviewed six courses and worked with the trainers to strengthen both the technical content and the pedagogical aspects. These courses were River Basin Hydrology, River Basin Water Resources Engineering, River Basin Irrigation Engineering, Environmentally and Socially Sound River Basin Management, Economics of River Basin Development, and Integrated Systems Operation. In addition, several sessions on various applications of Geographical Information Systems (GIS) to water resources planning and management and several tours of USU teaching facilities and local water resources projects were provided.

A. Bruce Bishop, David S. Bowles, James Christiansen, J. Nicholls Eastmond, Thomas B. Hardy, Trevor C. Hughes, J. Paul Riley, and Wynn R. Walker conducted the USU training program. Dr. Bowles served as Course Director and Jan Cochley, Chris Gunter, Limaye Ashutosh, and Sanjay Chauhan provided logistical support. •

International Irrigation Center Courses

Trainers in interdisciplinary courses offered by USU's International Irrigation Center (IIC) include UWRL faculty. The Center provides training and research to enhance the capabilities of professionals, scientists, and technicians abroad for improving irrigated agriculture in their countries. Staff of the IIC and its parent organization, the Biological and Irrigation Engineering Department, are involved in extensive research with emphasis on remote sensing, computer modeling, and software development. UWRL Director, Dr. Bowles, serves as a trainer for the IIC course entitled "Soil and Water Conservation and Management." He teaches participants about sediment transport in natural systems, sedimentation in storage reservoirs, and sediment mitigation measures including settling basin design principles. •

K-6 Education

International Office for Water Education

All living things require water. Although the world's supply of water remains constant, water distribution and quality vary greatly with time and location. Utah is the second driest state, and with a steadily increasing population, Utah citizens must become more knowledgeable and wise about the development, use, and conservation of their water supply. That is where the International Office for Water Education (IOWE) comes in. Its primary objective is to promote water education. Its goal in Utah is to make every elementary school teacher and student water literate.

Under the direction of Dr. C. Earl Israelsen, UWRL accomplishes its education plan through annual poster contests, teacher in-service sessions, credit workshops, school assemblies, and classroom demonstrations. Water education lessons and activities are also developed, printed, and distributed to Utah elementary and secondary schools. •

INTERNATIONAL OFFICE FOR WATER EDUCATION
UTAH STATE UNIVERSITY 1888

Water Education Book and Science Kit

IOWE distributes and inservices a 166-page Water Education K-6 Lesson and Activity Book to elementary school teachers. Educators and others interested in obtaining copies of the K-6 book and equipment kit may write to Dr. C. Earl Israelsen, IOWE Director, Utah Water Research Laboratory, Utah State University, Logan, Utah 84322-8200 or call 1-800-922-IOWE.

Donald R. Daugs, Professor of Elementary Education at USU, has recently completed writing a water education book for secondary school teachers. The book uses the Science, Technology, and Society (STS) approach, and the course will be used in Utah's ninth and tenth grades as part of the state's core curriculum.

Along with the Water Education Book, a new demonstration kit is offered that contains material and equipment for professionals to use when demonstrating water science activities in schools. Many professionals are asked to share information about their work with students but often have a difficult time in relating to them. The kit enables the presenter to involve students in hands-on activities that will help teach water science. •

Classroom Calendars

IOWE published Utah's Young Artists' Water Education Classroom Calendars in 1991, 1992, and 1993, and distributed them throughout the state to all elementary teachers, principals, state and local educators, funding agencies, governors, mayors, university professors, and state and federal bureaus such as the Department of Natural Resources, Department of Environmental Quality, Bureau of Reclamation, and US Geological Survey.

IOWE received a grant from the US Geological Survey to initiate a Powell Water Education Poster Contest and Calendar in six additional western states for the 1992-1993 school year. The program targeted almost two million elementary school students in Arizona, California, Colorado, Nevada, New Mexico, and Wyoming. Another grant has been received for the 1993-1994 school year to repeat last year's accomplishments in those states. In addition, IOWE is initiating a water education poster contest and calendar in six additional states: Idaho, Oregon, Washington, Montana, Hawaii, and Alaska.

There are 12 monthly activities, hard-to-find facts about western water, over 120 questions and answers, and a pull-out section containing background information for teachers. More than 7,500 elementary schools in 13 western states will have received copies of the calendars by the end of the next school year. •

Water Education Month and Banquet

IOWE and the Utah Division of Water Resources sponsors a Water Education Month and Banquet each October. In connection with these events, students can enter the IOWE-sponsored Young Artists' Water Education Poster Contest. Over $580,000 in donated prizes are awarded annually to contest winners. This year's theme is "Ground Water—A Natural Wonder." •

Public School Teacher Training

IOWE conducts one-credit-hour workshops for elementary and secondary teachers to show them how to teach math and science using water concepts. Workshops encouraged teachers to make water and environmental issues part of their classroom discussions. Educators and scientists from three universities (Brigham Young University, Southern Utah University, and Utah State University) conducted the workshops for participants from the following nine school districts: Cache, Box Elder, Beaver, Garfield, Millard, Salt Lake County, Alpine, Washington, and Sevier. The project was partially funded by the Department of Education through the Dwight D. Eisenhower Mathematics and Science Education Act. •

Elementary School Visits

MarDell C. Parrish, IOWE Educational Specialist, has conducted Utah in-service sessions, assemblies, and classroom demonstrations since 1986. The water education and science assemblies and demonstrations focus on concepts from the Utah's core curriculum, and include information on the hydrologic cycle, precipitation, physical, and chemical properties of water, and how water affects human activity. The demonstrations showed teachers new techniques for teaching about water.

Mr. Parrish visited schools in Carbon, Emery, Grand, Duchesne, Uintah, Daggett, Provo, Iron, Washington, and Kane school districts during the 1992-1993 school year. Additional workshops were held in Cache, Box Elder, Davis, Weber, and Jordan school districts. Funding for these activities was provided by the Utah Division of Water Resources. •

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Essentially all the science learned in the schools depends on the teacher. The teacher is the enabler, the inspiration and the constraint.
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