Water Resources Center

Annual Technical Report

FY 1999

Introduction

This year has seen changes for the Center for Water Resources (previously, the Center for Water and Wildland Resources). It has relocated from the UC Davis campus to the UC Riverside campus upon appointment of John Letey as Director. We can now be reached at University of California, Riverside, Rubidoux Hall - 094, Riverside, CA 92521 or by phone at (909) 787-4327 or email at cwres@ucr.edu. Although the location has changed, the commitment to the Center's mission -- to stimulate and support water-related research and education activities among the various academic departments and research organization -- remains intact.

Research Program

The Water Resources Center funded 22 projects for a total of approximately $600,000 last year with nearly every UC Campus participating. Following is a list of these projects. The research categories -- Hydrology, Climatology & Hydraulics; Aquatic Ecosystems; Water Quality; Water Development & Management Alternatives; Water Law, Institutions & Policy -- were all represented. This year 31 projects for a total of approximately $880,000 will be funded. WRC-Funded Research 1999-2000 Predicting Ground Water Nitrogen Removal in Riparian Zones Based on Plot and Landscape Scale Variables,Tracy Benning, UC Berkeley Bioremediation of Perchlorate in Ground Water,W. T. Frankenberger, UC Riverside An Institutional Analysis of the application of Urban Reclaimed Water to Agriculture in California, Brent Haddad, UC Santa Cruz A Microscale Approach to Simulating Seasonal Bioavailability Constraints on Intrinsic Biodegradation,Patricia Holden & Arturo Keller, UC Santa Barbara Assessment of Intraseasonal Variations in California Rainfall and the Role of the Madden and Julian Oscillation, Charles Jones,UC Santa Barbara Impacts of Altered Hydrologic Regimes on Carbon Isotope Signatures in Food Webs Supporting Salmonids in Northern California Rivers, Mary Power, UC Berkeley Mitigation of Extreme Flooding Events by Optimal Control of Flood Plain Storage Using the Adjoint Sensititivy Method, Bret Sanders, UC Irvine Impacts of Seasonal Terminal Electron Accepting Processes on Natural Attenuation of Chlorinated Compounds in Ground Water, Thomas Young, UC Davis Study of Ground Water Dynamics in the Kern Alluvial Fan, California, Jordan Clark & Hugo Loaiciga, UC Santa Barbara In-Situ Bioremediation of MTBE Contaminated Ground Water Using Biobarriers, Marc Deshusses & Mark Matsumoto, UC Riverside A Stochastic Sediment Supply Model for a Mountainous Semi-Arid Landscape, Thomas Dunne, UC Santa Barbara Understanding and Predicting Seasonal-to-Interannual Fluctuations in California Precipitation Using an Atmospheric General Circulation Model, John Farrara & Jin-Yi Yu, UC Los Angeles Transport and Fate of Nitrate-Nitrogen in Heterogeneous, Unsaturated Sediments Below the Root Zone,Thomas Harter & Jan Hopmans & William Horwath, UC Davis Mechanisms for Addressing Third-Party Impacts Resulting From Voluntary Water Transfers, Richard Howitt, UC Davis Evaluation of the Effects of Surface Water and Ground Water Interactions on Regional Climate and Local Water Resources, Xu Liang, UC Berkeley Sources of Inorganic Nitrogen Utilized by Salt Marsh Macroalgae: Identification Using Stable Nitrogen Isotope Ratios, Henry Page, UC Santa Barbara Feasibility of Using Bioaugmentation with Bacterial Strain PM 1 for Bioremediation of MTBE-Contaminated Vadose and Ground Water Environments, Kate Scow, UC Davis

Habitat Features and Aquatic Health: Evaluating California's Stream Bioassessment Procedure in Natural and Articifical Streams in a Grazed Eastern Sierra Valley, Kenneth Tate, UC Davis An Integrated Modeling Framework for Analyzing Wetlands Policies: Balancing Ecosystem Services and Economic Factors, Marca Weinberg, UC Davis Enhancing the Utility of In Vitro Digestive Fluid Extraction as a Management Tool for Contaminated Aquatic Sediments, Donald Weston, UC Berkeley How California Fishes Swim Upstream Past Rapids, Waterfalls and Human-Made Barriers, Malcolm Gordon, UC Los Angeles Soil Water Monitoring Using Geophysical Techniquest: Development and Applications in Agriculture and Water Resources Management, Yoram Rubin, UC Berkeley Kate Scow, UC Davis presented her research with the microbes to neutralize MTBE to the secretary of the California Environmental Protection Agency and other Cal EPA officials. Her research was funded by WRC Project #UCAL-W-924, "Feasibility of Using Bioaugmentation with Bacterial Strain PM 1 for Bioremediation of MTBE Contaminated Vadose Ground Water Environments" NIWR Funded Project #W-901, "New Approach of Assessing Regional Ground Water Vulnerability to Contamination" by Graham Fogg, UC Davis also resulted in a report to the Cal EPA officials and Secretary.

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Life History Strategies of California Native Wetland Plants: Implications for Wetland Creation and Restoration
Project Number	W-907
Start Date	07/01/1998
End Date	09/30/2000
Research Category	Biological Sciences
Focus Category #1	Wetlands
Focus Category #2	Ecology
Focus Category #3	Conservation
Lead Institution	University of California

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Eliska Rejmankova	Associate Professor	University of California	01

Problem and Research Objectives

Wetland plants have been recognized as one of the crucial components of wetland ecosystems. The plants not only provide critical habitats for waterfowl and other biota (amphibians, insects, mammals), they have also been shown to perform essential functions in wastewater treatment processes. The flora of marshes of the California Central Valley is quite species rich. Yet most constructed wetlands in this

region (as in other parts of the world) are species poor. We feel this is because wetland designers have access to limited information in their selection of potential plant species. This is certainly true for the inland marshes of California whose vegetation has never been described in a comprehensive volume. The situation is better for California salt marshes, mainly due to an excellent wetland restoration project directed by Zedler (1996). Comprehensive information on life history strategies of California wetland plants is severely needed. A suite of papers on the life histories of wetland plants from eastern North America (e.g., Wisheu & Keddy 1992, Boutin & Keddy 1993, Weiner & Keddy 1995) and Europe (Maltby et al. 1997; Murphy et al. 1990) is available to provide good comparative material once the data on California species are obtained. The need for more research concerning the wetland vegetation has been identified by many agencies, including the US Fish and Wildlife Service, California Water Resources Board, San Joaquin Valley Drainage Program and others. The following specific objectives were delineated to accomplish our goals: 1) Select wetland plants from inland marshes of northern California to represent the wide range of life history types. 2) Define the functions of these plants in respective wetland ecosystems. 3) Select traits that are responsible for these functions and screen plants for those traints. 4) Based on the trait matrices, define functional groups of plants 5) Prepare short comprehensive information sheets on each plant species. 6) Evaluate the potential reference wetlands for different inland wetland types.

Methodology

Seeds were collected from 34 wetland species, 24 native and 10 introduced. There were 13 annual and 21 perennial species. Species included grasses, sedges, reeds, and herbaceous types. In February 1999, a germination experiment was done in a growth chamber using petri dishes. In April 1999, a germination and seedling establishment experiment was done in a greenhouse using subsurface irrigated pots containing a mixture of commercial washed sand and potting soil. In order to define the functions of these plants, several properties for each species were observed: average seed weight, lag time (L, the time in days between the sowing of the seeds and the commencement of germination), the final germination proportion at the end of the experiment (G), maximum germination rate (Gmax, maximum proportion of germinated seeds that germinate in a single day), time to 50% germination (t50), relative growth rate (RGR), leaf area ratio (LAR, amount of leaf area per unit total plant mass), specific leaf area (SLA, amount of leaf per unit leaf mass), net assimilation rate (NAR, rate of increase in plant mass per unit leaf area), and leaf mass ratio (LMR, fraction of the total plant biomass allocated to leaves). Measurements of total height and root length were periodically made throughout the experiment. Phenological characteristics and other adult characteristics (when first flowered, first clone, set seed, etc.) were recorded. In June 1999, the greenhouse experiment was taken down and representative plants for each species was transplanted to 5 gallon buckets and moved outside to our field site at Spieth Reserve. Principal Component Analysis (PCA) was used in order to group the different species along axes of differnet properties. This was done using SYN-TAX 5.02 Mac. PCA performed on 21 species using 10 traits shows four functional groups of plants. The first group consists of primarily perennial species with light seeds,low L and high germination percentages (Ex: Lepidium latifolium, Epilobium ciliatum, Cyperus eragrostis, etc.). A second group consists of primarily (obligate) annual introduced species that have light seeds, low L values, and high germination percentages. They also have high RGR and SLA values (EX: Echinochloa crus-galli, Lythrum hyssopifolium, Polypogon monspeliensis, etc.). A third group consists of native (facultative) annual species that have heavy seeds, high L and t50 values, and low germination percentages (Ex: Polygonum spp. and Conium maculatum). The fourth group consists of native perennial species that have heavy seeds, high L and t50 values, and low RGR and SLA values (Ex: Scirpus spp.). The PCA performed on 34 species showed a similar trend with germination percentages, t50 and L values the primary axis and annual/perennial the secondary axis. In order to further evaluate these traits and plant

functional groups (Objectives #3, #4), a nutrient enrichment mesocosm experiment was performed outdoors at the Spieth Reserve in the summer of 1999. This experiment was done to determine the effects of nitrogen and phosphorus enrichment on biomass, nutrient allocation, and nutrient content of five different wetland macrophytes. Native and introduced species were chosen in order to assess the possible differences. Five wetland plant species were used in the experiment: Bidens frondosa (native annual Asteraceae family), Cyperus eragrostis (native perennial in Cyperaceae family), Echinochloa crustgalli (introduced annual in Poaceae family), Lepidium latifolium (introduced perennial in Brassicaceae family), and Phragmites australis (natve perennial in Poaceae family). Four-week-old seedlings were transplanted into 2-L pots filled with commercially washed sand. Two levels of nitrogen (high and low) and phosopherous (high and low) treatments and two water levels (flooded and drawdown) were used. Nitrogen and phosphorus solutions were injected into the substrate of each pot using a syringe and all other nutrients were directly added to the water every ten days. Measurements of total height, number of leaves, and other phenological characteristics were measured every ten days for each plant. After two months, all plants were harvested, weighed and dried. Seeds, flowers, leaves, stem, and roots (including rhizomes) were separated. Leaf area was measured using a LI-COR 3000A leaf area meter. The replicates for each treatment were bulked and ground. Subsamples from each treatment were taken and analyzed for total phosphorus and nitrogen.

Principal Findings and Significance

Preliminary analysis show no significant differences in biomass between flooded and drawdown treatments. L. latifolium and P. australis shows a tendency to have equal phosphorus tissue contents in both the above-ground and below-ground structures while the other species had higher phosphorus tissue contents in the above-ground structures. When phosphorus is not limiting, L. latifolium has high phosphorus tissue contents. In order to evaluate the potential reference wetlands, field sampling and work is being done in the summers of 1999 and 2000. Sites include wildlife refuges and natural wetlands such as sloughs. Sampling of plant above-ground biomass, measuring plant size, describing the surrounding plant community are all done as well as sampling of this year's dead plant tissue and soil.

Descriptors

wetlands, aquatic plants, plant growth and productivity, species distribution, life history strategies, wetland construction and restoration

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	New Approach for Assessing Regional Ground Water Vulnerability to Contamination
Project Number	W-901
Start Date	07/01/1998
End Date	06/30/2000
Research Category	Ground-water Flow and Transport
Focus Category #1	Groundwater
Focus Category #2	Solute Transport
Focus Category #3	Geomorpological and Geochemical Processes
Lead Institution	University of California

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Graham E. Fogg	Associate Professor	University of California	01

Problem and Research Objectives

A large portion of California's groundwater supply, which furnishes nearly half of domestic, urban, and agricultural water in the State, is vulnerable to degradation by pollutants originating from point- and non-point sources. Results of recent research (Fogg et al., 1995; Fogg and LaBolle, 1995) on regional-scale contaminant transport in a typical alluvial basin in California and trends in shallow groundwater quality (e.g., Anton et al., 1988; Frantz, 1994; Snow, 1988) strongly suggest there is real potential for groundwater quality in many basins to grow progressively worse well into the next century. Scientifically defensible policies for managing groundwater quality will not occur until (1) the long-term (decades to centuries) sustainability of groundwater quality in the presence of nonpoint-sources of contamination is better understood, (2) the cause-and-effect relationships between certain land management practices and basin-scale water quality is better defined, and (3) better tools become available for characterizing the vulnerability of aquifers to contamination as a function of space and time. The current lack of such knowledge and tools leads to divergent water quality management policies that are either too restrictive or too relaxed.

Methodology

The proposed approach is an outgrowth of the PI's experiences in modeling regional, nonpoint-source

contaminant transport in theSalinas Valley (Fogg et al., 1995; Fogg and LaBolle, 1995), which suggest that groundwater vulnerability or sensitivity to contamination can be estimated with surprising accuracy by focusing more on the system heterogeneity and long-term transport processes between the water table and well intakes. The key steps are (1) highly resolved, geologically realistic stochastic characterizations of the subsurface heterogeneity to help define preferential pathways and solute mixing processes (diffusive attentuation in silt and clay beds; dispersion) and (2) backward-time simulation of the transport processes to probablistically identify contaminant sources (Uffink, 1989; Wilson and Liu, 1995; LaBolle et al., 1996, in press). The characterization of heterogeneity is based on a novel geostatistical technique that has proven to be very effective in typical alluvial aquifer settings of California (Carle and Fogg, 1996, 1997; Carle, 1996, 1997; Carle et al., in press) and advanced geologic concepts (Weissmann and Fogg, 1995, 1996, 1997). Comparison between simulated and measured groundwater ages as well as DBCP concentrations for simulation times ranging from 5 to 50 or more years will provide a check on our ability to characterize aquifer vulnerability.

Principal Findings and Significance

The Kings River alluvial fan has major incised valleys that contain coarse-grained channel deposits and cut through the previously reported paleosol sequence stratigraphic architecutre, thereby creating pathways for significantly enchanced vertical flow of groundwater and contaminants. Because of the sequence stratigrpahic approach, these valleys are predictable in terms of their existence and location. In other words, a scientific basis has been developed for predicting or mapping locations of these zones of significantly greater vulnerability to contamination. Second, our high-resolution characterizations of the system heterogeneity and accurate simulations of transport proceses of advection, mechanical dispersion, and molecular diffusion show that natural mixing of groundwater of different ages in a typical alluvial aquifer system like this one results in significant variation in actual ages within a groundwater sample, even if that sample is obtained from a well having a narrow screened interval (e.g., <1m). The amount of variation in age within a given parcel of water can be decades to centuries, which means that a water sample that has been dated at, say, 50 yr, could easily contain H2O molecules that range in age from 1 to 100 yr. This is of profound importance for groundwater vulnerability analysis. For example, this helps explain why seemingly old groundwater often has detectable concentrations of contaminants. Perhaps most important, these findings suggest that if nonpoint sources of contaminantion do not diminish over time, groundwater contaminant concentrations will steadilty worsen in the future. This calls into question the common assumption that groundwater is sustainable, particularly in typical alluvial basins containing invensive agricultural and urban uses. Using a transition probability geostatistical approach and detailed hydrostratigraphic analysis, we built 30 geostatistical realizations to effectively simulate the multi-scale heterogeneous distribution hydrofacies within a 94.5 KM2 portion of the Kings River alluvial fan aquifer system. MODFLOW-96 was used to simulate the velocity fields, and an improved random walk particle tracking model (RWHET) was used to simulate solute transport. Backward time transport simulations were used to model the groundwater age distributions for various screened intervals. The multiple realizations provide a means of accounting for uncertainty regarding the hetrogenity. Spatially connected gravel and sand bodies in the system form a series of aquifers, which are the preferential pathways for groundwater flow and contaminant transport. Paleosols, ancient soils are laterally continuous, except where eroded out by incised valleys and represent uncomformities as well as semiconfining beds that bound the different depositional sequences. The distribution of these relatively low-permeability paleosols divide the alluvial fan system into different hydraulic units and reduces their connectivity. The simulation results show reduced dispersion and longer travel times for contaminant plumes in the vertical direction due to the existence of these paleosols. Therefore the paleosols tend to

reduce the susceptibility of deeper aquifers to pollution, but do not prevent contaminant plumes from eventually migrating into the deep aquifers. Since this multi-scale heterogeneity results in the slower vertical transport of contaminants, contamination might be expected to reach the deeper zones within several decades after being released at the ground surface. Pumping of water from deeper wells tends to increase the rate of downward solute movement. In addition, most of the models show that the movement of contaminant plume fronts are faster and lateral dispersion is larger in shallow zones due to the existence of the paleolsols. Also during this past year, the size of the study area was doubled to include the more complex central portion of the alluvial fan where incised valleys are known to exist, expanding greatly the scope of last year's effort out to a regional scale. Incised valleys were formed by ancient river channels. These channels generally cut into earlier paleosols forming breaks in the lateral continuity of the paleosols. The spatial distribution and geometry shape of an incised valley was characterized, based on high quality C-horizon soil mapping, 8 USGS continuous cores, 269 drillers' log data and 3 new cores collected recently. The stratigraphic character of each depositional system was modeled separately using the transition probability approach, in order to avoid the problem of non-stationarity which exists across boundaries formed by unconformities. After combining each sequence, we use the same method, outlined above, to simulate groundwater flow and contaminant transport. The modeling was performed for three senarios; without paleosols, with continuous paleosols, and with discontinuous paleosols. Model results show that the existence of an incised valley provides an enhanced pathway for groundwater flow and contaminant transport. The stratigraphic concepts developed during this research is already being applied in several study sites within California and elsewhere in North America. After presenting the results from this work at Lawrence Livermore National Laboratories, geologists began reassessing previous interpretations of the hydrostratigraphy based on these characterization methods. Also, the presentations at various meetings has led to inquiries about this hydrostratigraphic approach, possibly leading to improved aquifer characterization by individuals whose work concerns characterizing and modeling contamination in alluvial fan aquifer systems. Finally, a similar approach is being used to understand the hydrostratigraphy at two study sites in Sacramento County, and Modesto Irrigation District as well as other UC Davis investigators are pursuing application of the approach to other aquifer systems in the San Joaquin Valley. The age dating results are of profound importance for understanding aquifer vulnerability in typical alluvial basins like the Central Valley. For example, this helps explain why seemingly old groundwater often has detectable concentrations of contaminants. Perhaps most important, these findings suggest that if nonpoint sources of contamination do not diminish over time, groundwater contaminant concentrations will steadily worsen in the future. This calls into question the common assumption that groundwater quality is sustainable, particularly in typical alluvial basins containing intensive agricultural and urban land uses. Our results create fertile ground for future research on groundwater ages and aquifer vulnerability.

Descriptors

groundwater, contamination, transport, water quality, groundwater management, hydrogeology, subsurface characterization, groundwater vulnerability, nonpoint source, stochastic modeling

Articles in Refereed Scientific Journals

Weissmann, G.S., J. F. Mount, and G. E. Fogg, Glacially driven cycles in accomodtation space and sequence stratigraphy of a stream-dominated alluvial fan, Central Valley, California. Submitted to Journal of Sedimentary Research. Weissmann, G. S., and G. E. Fogg, 1999. Multi-scale alluvial fan heterogeneity modeled with transition probability geostatistics in a sequence stratigraphic framework. Journal of Hydrology, v. 226(1-2), p. 48-65. Weissmann, G. S., and S. A. Carle, and G. E. Fogg,

1999. Three-dimensional hydrofacies modeling based on soil survey analysis and transition probability geostatistics. Water Resources Research, v. 35(6), p. 1761-1770.

Book Chapters

Dissertations

Weissmann, G. S., 1999. Toward new models of subsurface heterogeneity: an alluvial fan sequence stratigraphic framework with transition probability geostatistics: Ph.D. Dissertation, University of California, Davis, 279p.

Water Resources Research Institute Reports

Conference Proceedings

Weissmann, G. S., E. M. LaBolle, and G. E. Fogg. 2000, Modeling environmental tracer groundwater ages in heterogeneous aquifer systems. Proceedings of the XIII International Conference on Computational Methods in Water Resources. Volume 2, Calgary, Alberta, Canada, June, 2000. p. 805-811. Presentations: Weissmann, G. S., and G. E. Fogg, 2000, Correlation of sequence boundaries between continental and marine strata. AAPG Annual Convention, New Orleans, April 16-19, 2000. Weissmann, G. S., Williamson, R. J., and Fogg, G. E. 1999, Modeling heterogeneity of stream dominated alluvial fan aquifer systems: implications for contaminant transport. GSA 1999 Annual Meeting, P. A-149.

Other Publications

Information Transfer Program

The Center for Water Resources, in collaboration with the Water Education Foundation, has developed a quarterly newsletter titled CURRENTS, that was mailed to over 3,000 recipients and is available online at www.waterresources.ucr.edu. The Center for Water Resources has relocated to UC Riverside and accordingly, developed a new website that has garnered approximately 200 visits to date and has provided visitors to view and download the recent Water Resources Center Call for Proposals 2000, all funded research executive summaries and information on upcoming water-related events, workshops and meetings. The Water Resources Center, through the main office, has filled approximately 60 requests for publications. The Water Resource Center Archives, located in Berkeley, has filled approximately 15,794 transactions. This includes titles used on the premises and borrowed. This information transfer fulfills the mission of the Water Resources Center to meet the research needs of the University of California's systemwide instructional, research, and service programs. Service requests through the Archives served the needs of undergraduate students, faculty and staff, interlibrary loans, and the general public. 1,397 publications were distributed worldwide to interested parties in both the public and private sectors. The Center's current publication inventory consists of 223 titles and most are available at no charge. The Archives' website www.lib.berkeley.edu/WRCA/internet.html was selected as a Links2Go "Key Resource" in the Hydrology topic. When Links2Go says the page is a Key Resource, the page is one of the most relevant pages related to that particular topic on the web today, using an objective statistical measure applied to an extremely large data set. The Center continues an active program of sponsoring conferences and workshops on timely topics at which the latest information available is presented to interested topics. The 22nd Biennial Ground Water conference was held on September 20-21, 1999. The Center also sponsored a workshop on

TMDLs in January, 2000. It was attended by approximately 55 UC Cooperative Extension personnel and other interested individuals related to water quality. The Second Biennial Rosenberg International Forum on Water Policy was held on October 3-5, 1999 in Barcelona, Spain. The conference theme was "Harmonization of Water Uses World-Wide". A Canadian Patent was awarded to George Chang for his Indole coliform test. Chang's research leading up to this patent was supported in two separte projects funded by the Water Resources Center. Water Resources Center project #W-813 by Jay Lund, Civil Engineering, UC Davis, assesses the willingness-to-pay for urban water supply reliability. The model was distributed by the California Urban Water Agencies' exective director to several economists working on this issue throughout the state. Several of these economists have contacted Jay Lund expressing interest in its application. This is an active area of interest for many of California's urban water utilities. Geomatrix Consultants, Inc., San Francisco has obtained permission from the California EPA to use anaerobic degradation of chlorinated hydrocarbons, as developed by Jay Keasling UC, Berkeley in WRC-funded project #W-849, to treat a Santa Clara County contaminated wastesite where Keasling originally obtained the microorganisms.

USGS Internship Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	N/A	N/A	N/A	18	N/A
Masters	N/A	N/A	N/A	19	N/A
Ph.D.	N/A	N/A	N/A	13	N/A
Post-Doc.	N/A	N/A	N/A	6	N/A
Total	N/A	N/A	N/A	N/A	N/A

Awards & Achievements

Approximately $1.5 million from other funding sources has been received by Principal Investigators to continue pursuing the research begun by the WRC's "seed" funds. Funding sources include, The Nature Conservancy, NOAA, National Science Foundation, US EPA and others. A graduate student funded from NIWR project #W-885 was appointed assistant professor at Colorado State University in the Department of Fish and Wildlife in January 2000. The WR Center Archives has received funding for two research projects. The proposal; "Survey of California Water and Irrigation Districts" received $8,860 will be used to create a comprehensive list of water districts and irrigation districts in California and a survey of the agencies' significant historical documents will be completed at the same time. The proposal; "San Franscisco Bay Fund Inventory of Projects" received $15,000 to develop an inventory and interactive information system for all San Francisco Bay Fund projects, with links to other systems. The Archives' website (www.lib.berkeley.edu/WRCA/internet.html) has been selected as Key Resources for the Hydrology topic by Links2Go. This means that Links2Go says the page is a "Key Resource" and is one of the most relevant pages related to hydrology on the web today. They use an objective statistical measure applied to an extremly large data set.

Publications from Prior Projects

Articles in Refereed Scientific Journals

Giblin, T. Herman, D. Deschusses, M. and W. T. Grankenberger. 2000. Removal of percholorate in water with a flow through bioreactor. J. Environ. Qual. (29), 578-583. Giblin, T., Herman, D. and W. T. Frankenberger. 2000. Removal of perchlorate from groundwater by hydrogen-utilizing bacteria. J. Environ. Qual. (29), 1057-1062. Grote, K., S. Hubbard, A. Lawrence, J. Harvey, M. Riemer, J. Peterson and Y. Rubin. 1999. Nondestructive monitoring of sub-asphalt water content using surface ground penetrating radar techniques. EOS (46), PF291. Weissmann, G. S., and G. E. Fogg. 1999. Multi-scale alluvial fan heterogeneity modeled with transition probability geostatistics in a sequence stratigraphic framework. Journal of Hydrology (226), 48-65. Weissmann, G. S. and S. A. Carle, and G. E. Fogg. 1999. Three-dimensional hydrofacies modeling based on soil survey analysis and transition probability geostatistics, Water Resources Research (6), 1761-1770.

Book Chapters

Giblin, T., D. Herman and W. T. Frankenberger. 2000. An autotrophic system for the bioremediation of perchlorate from groundwater. Ch. 18. Perchlorate in the environment. E. T. Urbansky, ed. Kluwer/Plenum Press. NY USA.

Dissertations

Water Resources Research Institute Reports

Rudnick, D. A., K. M. Halat, and V. H. Resh. 2000. Distribution, Ecology and Potential Impacts of the Chinese Mitten Crab (Eriocheir sinensis) in San Franciso Bay. Water Resources Center Contribution #206.

Conference Proceedings

Gabet, E. J. and T. Dunne. 1999. Sediment transport by overland flow: Field experiments and modeling results in EOS Transactions AGU (48), Fall Meeting Supplement F301. Morales, M. X. Wang, S. Revah and M. A. Deshusses. 2000. Microcosm and Column Studies on the Biodegradation of Methyl Tert-Butyl Ether (MTBE) in Soil-Water Systems In Proc. Annual Meeting and Exhibition of the Air and Waste Management Association, June 19-22. AWMA, Pittsburgh, PA. 12. Jones, C., D. Danielson, D. Gomberg, B. Bower. 2000. Mesoscale simulations of heavy precipitation in southern California during the 1998-98 El Nino. In Proc. of the 10th PSA/NCAR Mesoscale Modeling System Users' Workshop, National Center for Atmospheric Research, Boulder, Co. June 21-23. 107-109. Jones, C. 1999. Occurrence of extreme precipitation events in California and relationshps with the Madden-Julian Oscillation. In Proc. of the 24th Annual Climate Diagnostic and Prediction Workshop, Tucson, AZ, November 5-9. 363-366. Harter, T., K. Heeren, G. Weissmann, W. R. Horwath, J. Hopmans. 1999. Field Scale Characterization of a Heterogeneous, Moderately Deep Vadose Zone: The Kearney Research Site, in Proc. Chacterization and Measurement of the Hydraulic Properties of Unsaturated Porous Media, United States Salinity Laboratory, Riverside, CA 621-630.

Other Publications