FISCAL YEAR 1986
PROGRAM REPORT

LOUISIANA WATER RESOURCES RESEARCH INSTITUTE
Louisiana State University
Baton Rouge, LA 70803

Report No.
G1228-01

Fiscal Year 1986 Program Report
Grant No. 14-08-0001-G1228

for

U. S. Department of Interior
Geological Survey

by

Louisiana Water Resources Research Institute
Louisiana State University
Baton Rouge, LA 70803

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October 1987

ABSTRACT

The Louisiana Water Resources Research Institute's Fiscal Year (FY) 1986 Research Program addressed crucial water resources problems that were identified by the National Association of Water Institute Directors (NAWID) as priority problems for Louisiana and the Southern Plains Region. The areas researched - water quality, ground water hydrology, and flooding - were also important issues for the nation as a whole. The Institute funded three new projects and two continuation projects (one receiving a no-cost extension from FY 1985).

Flooding was the topic of two projects, one new and one continued from FY 1985. Specifically addressed were analyses of flood frequency and magnitude (Projects 02 and 05).

Water quality research addressed by the FY 1986 program focused on contaminant transport theory. Two projects contributed to this area, one studying chlorinated hydrocarbons (no-cost extension project) and the other, biocidal agents (Project 03).

The remaining project (Project 04) performed tritium dating of waters in the Baton Rouge aquifer recharge area. This project is expected to contribute information needed in answering questions of the importance of protecting this aquifer's recharge area.

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WATER PROBLEMS AND ISSUES FOR LOUISIANA

The most recent identification of problems and issues for Louisiana has been provided by the National Association of Water Institute Directors (NAWID) - Southern Plains Region. The problem listing and the subsequent prioritization of these problems served as the base from which to develop the Institute's Fiscal Year (FY) 1986 Research Program. These problem areas are documented in Table 1.

Important emerging water resources issues in Louisiana are the problems associated with wetlands and coastal zones, water resources planning, and water quality standards. These issues are not addressed in the Institute's FY 1986 program, however, as their importance in the state increases, they may need incorporation into future fiscal year programs.

Louisiana's vast wetlands make up approximately 40% of the nation's wetlands. These areas are composed of very sensitive, often delicately balanced ecosystems, and are therefore particularly vulnerable to contamination or destruction during commercial development. The risks the wetlands face during development and the economic valuation of these areas are not currently well understood, making them vulnerable to misuse.

Coastal problems are of major importance in Louisiana. The coastal terrain is flat, therefore a small increase in sea level or a small amount of land subsidence results in a receding coast line. Land loss due to subsidence is a particularly serious problem in Louisiana. Consolidation of geologically young sedimentary deposits and withdrawals of oil, gas and water are the major contributors to the subsidence problem. The result is severe coastal erosion and land loss at a rate of between 30 to 50 square miles of Louisiana's coastal lands each year. Obviously this rate of loss can be translated into serious environmental and economic losses for the state.

Water resources planning is an unmet need of the state. The current fiscal crisis of the state is leading to the slashing of state water resources agency budgets in a desperate attempt to cope with the multi-million dollar deficit. Financing of water resources projects by state and local governments is becoming increasingly difficult as cost sharing obligations for federal projects increase. How to meet the new demands for limited dollars presents a challenge to state water resources planners. Planning and prioritization at the state level are virtually non-existent at this time although they are more needed now than ever.

Water quality standards of the state need reexamination. The nitrogen to phosphorus ratio, currently utilized to indicate the toxic effects of nitrogen levels, is not an adequate standard with which to address toxicity problems for fish and aquatic life, or the problems of methemoglobinemia (blue babies) in humans.

Table 1. Water Research Needs for the Southern Plains Region in 1986 (Source: National Association of Water Institute Directors)

Research Topic

Ground Water Quality Control
   Sources of toxic materials, Fate and transport of chemicals, Salinity management, Aquifer restoration techniques, Disposal and treatment systems

Surface Water Quality Control
   Sources of toxic materials, Salinity management, Watershed management for erosion and pollution control, Eutrophication, Disposal and treatment systems

Management of Surface Water Supplies
   Conjunctive surface and ground water management, Floodwater control, Flood prediction, Agricultural water conservation, Land use/hydrology interaction, Drought prediction and management, Watershed management for rainfall use efficiency, Water reuse, Utilization of brackish waters

Management of Ground Water Supplies
   Conjunctive ground and surface water supplies, Techniques for parameter measurement

Political and Economic Issues
   Water allocation and reallocation, Water values for alternate uses, Flood damage assessment

Legal and Institutional Issues
   Conflict resolution among competing users, Conservation incentives, Wildlife protection incentives, Water demand forecasting, Ground water management, Constraints to surface water management

Ecological, Health and Environmental Relationships
   Wetland hydrology, Impact of chemicals on wildlife, Effect of adjoining land use on coastal and shoreline water uses, Effect of chemicals in water on human health

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These are but a few of the concerns and questions that are impacting state decision makers, and are questions that the Louisiana Water Resources Research Institute could, in part, help address through its research program.

PROGRAM'S GOALS AND PRIORITIES

The Institute's goal for the FY 1986 program was to address the highest priority water resources problems and issues identified for Louisiana. Problem areas receiving top priority rating were:

- Water quality,

- Water resources management, and

- Flooding.

The Institute identified three primary objectives to pursue in helping meet its FY 1986 goal.

- Support quality research in the priority problem areas,

- Provide for the training of future scientists and engineers who will be better equipped to solve these problems, and

- Facilitate information and technology transfer by planning or promoting activities that help communicate the findings and progress of the funded research.

Quality research was supported, providing grant funds to faculty members proposing research in the highest priority areas. Four research projects were supported by the FY 1986 funds, and one project begun in FY 1985 continued its investigations under a no-cost extension for FY 1986. Together these projects performed tasks that have contributed directly to the better understanding of the problems/ issues for Louisiana, and in addition, are providing answers for some of the more pressing problems.

The second Institute objective, to train new scientists and engineers, was accomplished through support of student work and research in conjunction with the five research projects conducted during the year. A summary of these accomplishments is provided in the section, TRAINING ACCOMPLISHMENTS, appearing later in this report (See page 22).

Information transfer efforts (Objective 3) for FY 1986 included initiating a newsletter, assembling an exhibit for an in-state conference, publishing articles in technical journals, and sponsoring a state-wide conference on water resources. These

activities are presented in greater detail and summarized in this report's INFORMATION TRANSFER ACTIVITIES section, page 19.

RESEARCH PROJECT SYNOPSES

Four research projects were supported by the FY 1986 funds, and one project begun in FY 1985 continued its investigations under a no-cost extension for FY 1986. Of these projects, two addressed water quality issues relevant to Louisiana, two focused on flooding, and one addressed resource management issues. Projects funded were:

"A Simplified Extreme Value Method of Flood Frequency Prediction for Louisiana Streams"

"Evaluation of Factors Influencing Migration and Transport of Biocidal Agents to Ground Water and Surface Water Resources"

"Tritium Dating in the Recharge Area of the Baton Rouge Aquifer"

"A Multivariate Stochastic Analysis of Flood Magnitude, Duration and Volume" (Continued from FY 1985)

"Transport of Chlorinated Hydrocarbons through Saturated Cohesive Deposits in Southern Louisiana" (No-cost extension from FY 1985)

A synopsis of each project follows.

Project Number: 02   Start: 09/86
                                             End: 08/87

Title: A Simplified Extreme Value Method of Flood Frequency
          Prediction for Louisiana Streams

Investigator: James F. Cruise
               Department of Civil Engineering
               Louisiana State University

COWRR: 02-E   Congressional District: Sixth

Descriptors: Flood frequency, flood forecasting, statistical
               methods, stochastic processes, Louisiana

Problem and Research Objectives: Because streamflow is a random
variable, uncertainty and risk are inherent properties in the
design of any water resources project. In order for an analysis
of the risk of structural or functional failure of a project to
be performed, exceedence probabilities must be assigned to design
discharges. There is currently much debate about the proper
method of calculating these probabilities. The method currently
mandated for use by federal agencies by the U.S. Water Resources
Council (1981) involves the fitting of a three parameter proba-
bility distribution to the logarithms of the observed annual
maximum peaks. This fitting is accomplished by the method of
moments.

     The WRC methodology has been subjected to severe criticism
in recent years. This criticism generally involves the
difficulty in obtaining accurate estimates of the third moment of
the distribution. There are rarely sufficient data available at
a given site to obtain this estimate directly. To overcome this
difficulty, the WRC now recommends the use of a regional
estimator of the third moment based on the records of gages in
the study area with similar characteristics. However, this
procedure has also been found to be vague and unsatisfactory.

     In recent years another philosophy of flood frequency
analysis has been gaining popularity. This method involves
fitting a probability distribution to the series of all recorded
flood peaks above a given base level (called the partial duration
series) rather than the annual maximum values only.
Probabilities from this distribution can then be converted to
equivalent annual probabilities by a procedure developed by
Todorovic (1970). The advantages of this procedure are that more
data are available in the partial series than in the annual
maximum series and that the stochastic structure of the stream-
flow series is explicitly accounted for.

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This project combines components of these two methodologies to develop a simplified method of flood frequency analysis which is more accurate than the method currently in use. WRC methodology is utilized to fit the log Pearson type III distribution function to the partial duration data series and probability estimates from this distribution are converted to annual values by the Todorovic method. It is believed that this procedure will result in more accurate quantile estimates than the WRC procedure alone.

The specific objectives of this study are:

1. To test the validity of WRC methodology to the partial duration data series.
2. To determine if sufficient data exists on Louisiana streams to derive stable estimates of the statistical parameters of the partial duration series.
3. To determine the effects of changes in the base level on quantile estimates from the proposed procedure.
4. To derive and standardize an algorithm for estimating flood probabilities on Louisiana streams using the proposed method.

Methodology: In this model the flood process is conceptualized as a compound Poisson process. The year is broken into seasons such that flood magnitudes within each season can be considered to be independent, identically distributed random variables. Furthermore, it is assumed that the number of events per season is a Poisson distributed random variable with mean $\lambda(t)$, where λ is the rate of the process. Then the distribution of the largest value from this process has been shown by Todorovic to be:

$$\phi(x) = \exp(-\lambda(t)(1-F(x))) \qquad (1)$$

where: $\phi(x)$ = distribution of the largest value of variate x; $F(x)$ = underlying (partial duration) distribution of the magnitudes of x. The annual probability of any exceedence from this model can be obtained by multiplying the season probabilities.

In this study a log Pearson type III distribution was used as $F(x)$. This distribution is recommended for use with maximum annual peaks by the WRC. Since it is known that the forms of the distributions of the annual series and the partial duration series must be the same, this distribution function was fitted to the partial series by the method of moments. A discussion of the distribution and the fitting procedure can be found in the WRC Bulletin 17B Guidelines (1981). Seasonal probability estimates were obtained from this distribution by using equation (1) and then the seasonal probabilities were multiplied to obtain annual values.

The procedure discussed above was applied to 19 data sets in Louisiana. These sets represent all basins in the state at which the USGS collects partial duration data and which had a period of record of at least 20 years. These records were broken into increments representing a winter season (Nov.- April) and a summer season (May-Oct.). The Poisson parameter ( ) and the distribution parameters were obtained for each season. With these parameters, annual quantiles corresponding to specified exceedence probabilities could then be obtained. These results were then compared to observed probabilities calculated according to the standard plotting position formula (Beard, 1962).

Principal Findings and Significance: In every case it appears that the proposed procedure results in a good fit to the observed data. In all cases, sufficient data were available to obtain accurate estimates of the distributional parameters. This fact alone makes the procedure superior to the current method of at-site analysis. Because the LP III is a 3 parameter distribution, it is relatively insensitive to base level selection. It appears that as long as the base level is set high enough such that serial independence is obtained, the LP III will have no trouble conforming to the resulting data series. In fact, the procedure showed more flexibility in this regard than did the annual procedure currently in use. In every case the proposed procedure appeared to visually fit the observed data at least as well as the current method, and, in many instances, a better fit was obtained.

It should be noted, however, that this flexibility of the procedure is not necessarily a good attribute since it allows the distribution to take on forms which may not be truly representative of the distribution of flood magnitudes. It also means that the procedure is very sensitive to high values in the data series. Significantly high values exerted a decided influence on the resulting form of the LP III distribution. Since there is presently no way to handle outliers in the Poisson model, no correction for this bias toward the higher values could be made. Therefore, care should be exercised when applying the procedure to cases where high values or outliers are present in the data series.

Publications and Professional Presentations:

"On The Application of the Poisson Partial Duration Flood Model", Journal of Hydrology (submitted).

"The Application of the Poisson Partial Duration Model With a Log Pearson type III Distribution" (To be submitted to either Journal of Hydrology or Water Resources Bulletin).

M.S. Theses and Ph.D. Dissertations: None

Project Number: 03   Start: 09/86
                                             End: 08/87

Title: Evaluation of Factors Influencing Migration and Transport
        of Biocidal Agents to Ground Water and Surface Water
        Resources

Investigator: Dipak Roy and Donald D. Adrian
               Department of Civil Engineering
               Louisiana State University

COWRR: 05-B   Congressional District: Sixth

Descriptors: Herbicides; biodegradation; pollutants; transport
        depletion; 2,4-D; 2,4,5-T; hydrogeology

Problem and Research Objectives: Groundwater is a critical
resource serving over 100 million Americans. Contaminants usual-
ly enter the groundwater from the land surface, percolating down
through the aerated soil and vadose zone. Agricultural chemicals
such as pesticides and herbicides added to soil surface to attain
a higher crop yield have often been found in groundwater because
of their low rate of transformation. The fate and transport of
pesticides and herbicides in soil and groundwater systems depend
on a number of physical, chemical and biological processes in
nature. Inorganic hazardous substances such as heavy metals have
also been reported to pose potential contamination p.roblems for
groundwater resources.

The specific objectives of this study were:

1. To study the adsorption desorption behavior of 2,4-D and
2,4,5-T on soil samples at various levels of organic content,

2. To study the surface associated growth of Isolates DR
101 and DR 201 on various soil samples, and

3. To evaluate the effect of adsorption of chemicals and
microorganisms on soils on the biodegradation of 2,4-D and 2,4,5-
T by Pseudomonas Isolates DR 101 and DR 201.

Methodology: This research evaluated the soil-chemical-microbe
interactions influencing the contaminant transport to ground and
surface water resources using model chemical compounds, well
characterized microbes capable of biodegrading the selected
chemicals and synthetic soil samples representative of natural
environment. The chemicals, microbes and types of soil used in
this study were:

Herbicides: 2,4-D and 2,4,5-T

Microorganism: $\underline{Pseudomonas}$ Isolates DR 101 and DR 201 isolated, purified and characterized in our laboratory.

Soil Sample: Sand, montmorillonite, kaolinite and humic acid mixed in predefined quantities to synthesize representative soil samples.

The pure cultures of Pseudomonas Isolates DR 101 and DR 201 were kept in screw cap sterile flasks (200 to 300 ml) at a constant temperature (30 C) on a shaker water bath (100 to 150 cycles per minute). The effects of mercury were evaluated by monitoring the oxygen uptake rate in the electrolytic respirometer. The electrolytic respirometer consisted of three major parts: (1) a one liter reaction vessel which contains the sample and a magnetic stirring bar to provide mixing, (2) an adaptor unit which sits on the reactor bottle containing potassium hydroxide to absorb the carbon dioxide from the atmosphere above the sample, and (3) an electrolytic cell which contains a weak electrolyte such as sulfuric acid (0.1 N H_2SO_4). The electrolytic cell served as a manometer to detect pressure changes and as an oxygen generator to maintain a constant partial pressure in the atmosphere within the reaction vessel. Oxygen uptake by the microorganisms was the same as the oxygen production needed to equalize the pressure and was reported by the respirometer in mg/l at a preset time interval.

Chemicals: Stock solutions of 2,4-D were prepared by dissolving appropriate quantities in 1.0 N NaOH to produce a final concentration of 25 mg/ml.

Basal Salt Media (BSM)(10x): BSM was prepared by dissolving 58.0 g K_2HPO_4, 45.0 g KH_2PO_4, 20.0 g $(NH_4)_2SO_4$, 1.6 g $MgCl_2$, 200.0 mg $CaCl_2$, 20.0 mg $NaMoO_4$, and 10.0 mg $MnCl_2$ in one liter deionized water.

Mercury (II) Chloride: Stock solution of $HgCl_2$ was prepared by dissolving an appropriate quantity in deionized water to produce a final concentration of 50.0 mg/l.

Culture Media: The culture media was prepared by adding 100.0 ml BSM (10x), 50 ml seed (DR 101 or DR 201), 70 ml chemical (2,4-D), and the necessary amount of mercury (II) chloride and deionized water to prepare a total volume of one liter. Mercury concentrations (0.1, 0.5, 1.0, and 2.0 mg/l as Hg^{++}) in the reactor were obtained by diluting the stock solution.

<u>Principal Findings and Significance</u>: The findings of this research study are summarized below:

1.   The two new $\underline{Pseudomonas}$ isolates are capable of

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degrading herbicides 2,4-D and 2,4,5-T.

2. These isolates are capable of degrading the herbicides in the presence of mercury, lead and cadmium.

3. Mercury was observed to affect the rate of biodegradation of herbicides. However, lead and cadmium when present in concentration levels reported in waste did not significantly affect the rate of biodegradation of the herbicides by the two Pseudomonas isolates.

4. A mathematical framework for the degradation and transport of herbicides in soil was developed incorporating all major physical, chemical and microbiological processes.

Publications and Professional Presentations:

"A Study of Biodegradation of Pesticides in Soil", Singhal, N., Sebuktekin, I., Roy, D., and Adrian, D.D., Proceedings of the International Symposium on Environmental Management, Istanbul, Turkey, June, 1987.

"Effects of Mercury on the Biodegradation of 2,4-Dichlorophenoxy Acetic Acid (2,4-D) by Two New Pseudomonas Isolates", Sebuktekin, I., Singhal, N., and Roy, D., Presented before the Division of Environmental Chemistry, Annual Meeting of American Chemical Society, New Orleans, LA, August 30-September 4, 1987.

"Effect of Mercury Toxicity on the Biodegradation of Pesticides", Presented at Annual Meeting of Louisiana Water Pollution Control Association, New Orleans, April, 1987.

M.S. Theses:

Effect of Heavy Metals on the Biodegradation of 2,4-D by Two New Pseudomonas Isolates. Isik Sebuktekin, Louisiana State University, August, 1987.

Ph.D. Dissertations: None

SYNOPSIS

Project Number: 04   Start: 09/86
                                                      End: 08/87

Title: Tritium Dating in the Recharge Area of the Baton Rouge
            Aquifer

Investigators: Michael A. Simms, Paul Aharon, Ray E. Ferrell,
                 Department of Geology and Geophysics
                 Louisiana State University

COWRR: 02-F   Congressional District: Sixth

Descriptors: Groundwater,   recharge,   tritium,   aquifer,
                contamination, Louisiana.

Problem and Research Objectives: This project addressed the
critical question of the spatial distribution and rates of
recharge to the Miocene-Pliocene-Pleistocene age aquifers (the
"Baton Rouge Aquifers" or the Southern Hills Regional Aquifer
System of Buono, 1983) that constitute the primary source of
domestic and public water supply in Baton Rouge, Louisiana and in
neighboring southeastern Louisiana and southwestern Mississippi.
The extent of the recharge area of these aquifers and the rates
and patterns of recharge are critical in evaluating the potential
threats of aquifer contamination due to waste disposal and land-
use practices in the recharge area.   Contamination in zones of
high recharge rate will be most threatening to water quality in
the aquifer.   Zones of lower recharge rate will not readily
introduce contaminants into the aquifers.   At present, the extent
of the recharge area is only roughly known and the rates and
patterns of recharge within it are poorly understood.

    The Miocene-Pliocene-Pleistocene age aquifers are gulfward-
dipping unconsolidated sands interlayered with clay and silt
confining beds.   The section occupied by freshwater thickens
southward to a maximum of nearly 3000 feet in the vicinity of the
Baton Rouge Fault Zone.   The Baton Rouge aquifers are unconform-
ably overlain in most of the study area by the Citronelle Forma-
tion of Pleistocene age.   The Citronelle Formation is composed
of mud, sand, and gravel varying in thickness from about 30 to
290 feet.

    Groundwater moves throughout the aquifer system in response
to topographic differences from north to south.   Recharge occurs
at high elevations in Southern Mississippi and in East Feliciana
Parish, Louisiana. Groundwater generally flows downward into the
aquifer system and southerly along the layering. Upward flow and
discharge from the system occurs at low elevations and is located
near normal faults that obstruct the regional flow system.

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Rates of input and flow in this aquifer are currently unknown. The purpose of this study is to (1) demonstrate that recharge is occurring in the areas of higher elevation north of Baton Rouge, (2) determine the distribution of rates of recharge and (3) determine the dependence of recharge rate on topographic form and subsurface geology. Recharge rates constitute the boundary inputs of the aquifer system. Knowledge of the distribution of recharge rates allows elevation of the threat of contamination of the aquifer system and allows specification of boundary conditions in aquifer models.

Concentration of tritium, a radioactive isotope of hydrogen with a half-life of 12.26 years, were measured in shallow groundwater to locate the occurrence of young groundwater. Tritium concentrations were elevated in rainfall during the 1950's and 1960's due to atmospheric testing of thermonuclear weapons. Determining the depths and locations of this high-tritium groundwater demonstrates that recharge is occurring and provides an approximate measure of the rate of downward movement of recharging groundwater.

Hydrogeochemistry and oxygen isotope composition also provide information concerning the source and flow patterns of the groundwater.

Together, these sources of data provide a comprehensive description of patterns and rates of recharge in the recharge area of the Baton Rouge Aquifer.

Methodology: A roughly north-south transect from Pride, Louisiana to the vicinty of the Homochitto River in Franklin County, Mississippi was chosen as the study area. This transect is approximately normal to the equipotentials throughout the aquifer system and therefore represents the surface trace of a longitudinal cross-section through the aquifer system. The recharge area continues northward to the vicinity of Jackson, Mississippi.

Location, depth, and screening data was gathered concerning more than 500 domestic and municipal wells scheduled by the U.S. Geological Survey in the relevant area of Louisiana and Mississippi. Over 300 scheduled and unscheduled wells were visited in the field. Water samples were collected from 120 of these. Each well sample consisted of one 1-liter and two 1/2-liter plastic bottles filled after thorough purging of the well. Seventy-six samples have been analyzed for tritium concentration with 24 more currently undergoing analyses. Chemical and isotopic compositions have been determined for 100 samples.

Tritium measurements were performed using a procedure in which the sample is electrolytically enriched in tritium and counted in a liquid scintillation spectrometer. Results are

reported in Tritium Units (TU). One TU is an abundance of 1 tritium atom per 10^{18} atoms of hydrogen. The detection limit of this method is 1.5 TU or 4.79 pCi/l and the standard error of the determination based on repeats is estimated to be $\pm$ 6%.

The oxygen isotopic composition of the groundwater samples were measured according to the Epstein-Mayeda method. The O-18/O-16 ratios of the sample are reported in per mil deviation relative to the V-SMOW standard.

Major and minor element geochemistry of the samples were determined with an Inductively Coupled Plasma Spectrometer.

Principal Findings and Significance: The precise determination of recharge rates from tritium data requires that subsurface tritium concentration profiles be measured at locations of interest and compared to the atmospheric input of tritium during the last few decades. In the Baton Rouge area, tritium in rainfall has been measured only during 1964. Data from other recording stations in nearby states suggests that tritium levels in rain were elevated during the late 1950's and 1960's, but the form of the input function is therefore unavailable. Furthermore, our study relied on existing water supply wells. Therefore, we have established profiles based on wells of different depths in a small area rather than at a point.

The goal of our study was to delineate the zone of tritiated groundwater which represents recharge since the late 1950's. Our results, based on 8 profiles and isolated measurements in intervening areas, show the variation of recharge along the transect of the study area and the variation of recharge with topography. Recharge rates have been calculated based on the depth of the interface between tritiated and tritium-dead groundwater. This depth is divided by 30 years to get the rate of vertical groundwater movement in feet per year. Recharge rates are obtained by multiplying the vertical flow rate by an estimated average porosity of 0.30. Recharge rates vary from 1 ft/yr in the southern part of the study area (northern East Baton Rouge Parish) to 1.5 ft/yr in the northern part near Bude, Mississippi. Recharge rates are lower or equal to zero along valley sides and valley bottoms. Most recharge is occurring along major groundwater divides.

Publications and Professional Presentations:

Presentation to Groundwater Technical Group, Louisiana Section, American Water Resources Association, Baton Rouge, LA, June 30, 1987.

M.S. Theses: None

Ph.D. Dissertions: None

SYNOPSIS

Project Number: 05   Start: 09/85
                                                      End: 08/87

Title: A Multivariate Stochastic Analysis of Flood Magnitude,
          Duration and Volume

Investigators: Singh,   Vijay   P.
                    Departrment of Civil Engineering
                    Louisiana State University

COWRR: 1-E, 6-B, 8-B   Congressional District: Sixth

Descriptors: Flood forecasting, entropy, statistical analysis,
   and stochastic processes.

Problem and research objectives: A wide spectrum of civil works
require frequency distributions of flood magnitude, duration and
volume.   The   bulk   of hydrologic literature available   on
stochastic modeling of floods is devoted to deriving a frequency
distribution of the largest annual flood peak.   By comparison,
very limited research has been reported on frequency analysis of
concurrent flood duration and volume.   Furthermore, current
observations of sufficient length on magnitude, duration and
volume may usually not be available.   Thus, the objective of this
research was to determine multivariate distributions of these
variables with limited data or information, and also apply them
to sediment yield, pollutant loading, design of rainfall net-
works, etc..

Methodology: The procedure developed in this study employed
entropy which is a numerical measure of uncertainty associated
with representing a random variable.   By maximizing entropy
subject to the given information (or contraints) on the flood
variables, the least biased probability distributions are then
tested using real-world flood data from a number of river basins
in the USA.

Principal findings and significance: The results of this study
can be summarized as follows: (1) Entropy and principle of
maximum entropy (POME) can be applied to derive any probability
distribution expressible in direct form.   (2) Most probability
distributions used in hydrology have been derived using POME.
(3) The procedure of derivation yields a method of distribution
parameter estimation.   (4) The entropy method unifies the extreme
value analysis and time series analysis.   Therefore, it is
possible to reconstruct the past records and forecast the future
records.   (5) The entropy method has been extended to design of
hydrologic networks and sediment and pollutant transport.   (6)
The entropy method has been found to be comparable with other

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methods of parameter estimation. (7) The entropy method provides a unique procedure for determining optimum number of raingage networks both in space and time. This procedure can be extended to other data acquisition systems. (8) The entropy method leads to a bivariate stochastic model for sediment yield prediction. (9) The entropy method results in a stochastic pollutant loading estimation.

Publications and professional presentations: The following publications have resulted from this study and associated studies funded by the Institute over the past three years:

Singh, V.P., Rajagopal, A. K. and Singh, K.,"Derivation of Some Frequency Distributions Using the Principle of Maximum Entropy (POME)," Advances in Water Resources, Vol. 9, No. 2, pp. 91-106, 1986.

Jain, D. Singh, V.P., "A Comparison of Transformation Methods for Flood Frequency Analysis." Water Resources Bulletin, Vol. 22, No. 6, pp. 903-912, 1986.

Singh, V.P., "On the Log-Gumbel (LG) Distribution." Hydrology Journal of the IAH, Vol. VIII, No. 4, pp. 34-42, 1986.

Jain, D. and Singh, V. P., "Estimating Parameters of EV1 Distribution for Flood Frequency Analysis". Water Resources Bulletin, Vol. 23, No. 1, pp. 59-72, 1986.

Singh, V. P. and Krstanovic, P. F., A Multivariate Stochastic Flood Analysis Using Entropy. Completion Report, Louisiana Water Resources Research Institute, Louisiana State University, Baton Rouge, Louisiana, 1986.

Singh, V. P. and Krstanovic, P. F., "Space Design of Rainfall Networks Using Entropy." Proceedings, International Conference on Water Resources Needs and Planning in Drought Prone Areas, Khartoum, Sudan, December 6-12, 1986.

Singh, V. P., "On Application of Weibull Distribution in Hydrology." Water Resources Management, Vol. 1, No. 1, pp. 33-43, 1987.

Singh, V.P. and Rajagopal, A.K., "Some Recent Advances in Application of the Principle of Maximum Entropy (POME) in Hydrology." IAHS Publication No. 164, Proceedings, International Symposium on Water for the Future, Rome, Italy, pp. 353-364, April 6-11, 1987.

Singh, V.P. and Singh, K., "Parameter Estimation for TPLN Distribution for Flood Frequency Analysis." Water Resources Bulletin, in press, 1987.

Arora, K., and Singh, V.P.,"On Statistical Intercomparison of EV1 Estimators by Monte Carlo Simulation." Advances in Water Resources, Vol. 10, No. 2, pp. 87-107, 1987.

Singh, V.P. and Krstanovic, P.F., "A Stochastic Model for Sediment Yield Using the Principle of Maximum Entropy." Water Resources Research, Vol. 23, No. 5, 781-793, 1987.

Singh, V.P., "On the Extreme Value (EV) Type III Distribution for Low Flows." Hydrological Sciences Journal in press, 1987.

Singh V.P. and Rajagopal, A. K., "A New Method of Parameter Estimation for Hydrologic Frequency Analysis." Hydrological Science and Technology: Short Papers, in press, 1987.

Arora, K. and Singh, V. P., A Comparative Evaluation of the Estimators of Some Flood Frequency Models Using Monte Carlo Simulation. Completion Report, Louisiana Water Resources Research Institute, Louisiana State University, Baton Rouge, Louisiana, 1987.

Fiorentino, M., Arora, K. and Singh, V.P., "The Two-Component Extreme Value Distribution for Flood Frequency Analysis: Another Look and Derivation of a New Estimation Method." Stochastic Hydrology and Hydraulics, Vol.__, No. __, pp. __. 1987.

Singh, V.P. and Singh, K., "Parameter Estimation for Log-Pearson Type III Distribution by POME", Journal of Hydraulic Engineering, ASCE, Vol.__, No.__, pp.__, 1987.

M.S. Thesis:

A Comparative Evaluation of Methods of Frequency Analysis and Estimation of Parameters, D. Jain, Department of Civil Engineering, Louisiana State University, May 1986.

A Comparative Evaluation of Estimators of Commonly Used Flood Frequency Models, under preparation by K. Arora, Department of Civil Engineering, Louisiana State University, December 1986.

Ph.D. Dissertations:

Entropy Theory and its Application to Flood Analysis, under preparation by P. F. Krstanovic, Department of Civil Engineering, Louisiana State University, expected December 1987.

SYNOPSIS

Project Number: No-cost Continuation   Start: 09/85
                                                        End: 08/87

Title: Transport of Chlorinated Hydrocarbons through Saturated
          Cohesive Deposits in Southern Louisiana

Investigator: Acar, Y.B.,
                 Louisiana State University
                 Baton Rouge, Louisiana

COWRR: 05-B   Congressional District: Sixth

Descriptors: Hydrocarbon, Chemical Wastes, Pollutants, Conta-
        mination, Clays, Louisiana, Permeability Coefficients, Dis-
        persion, Adsorption

Problem and Research Objectives: The study assessed the various
effects of trichloroethylene on the geotechnical properties of
cohesive deposits in Baton Rouge-New Orleans industrial area.
The effect of trichloroethylene on permeability, adsorption and
dispersion coefficient is determined by testing undisturbed spe-
cimens of the deposit obtained from a boring at a representative
location in the area.

Methodology: Regional geology and geotechnical properties of
Baton Rouge-New Orleans industrial district was reviewed. A site
was selected that appropriately represented the Pleistocene depo-
sits in the area. Borings were obtained at selected locations
through the funding provided by a local geotechnical engineering
company.   Undisturbed soil specimens were retrieved.   After a
logging of the borehole and classification of deposits at the
site, permeability tests were conducted. Transport related para-
meters, namely retardation factor and formation resistivity
factor for these deposits, and dilute trichloroethylene were
experimentally evaluated in the laboratory.   The time required
for trichloroethylene to break through a clay liner and the
contaminant to reach ground water under these geological and
geotechnical conditions was predicted.

Principal Findings and Significance: The results indicate that
under the laboratory determined operational variables, a hydrau-
lic conductivity of 1 X 10^{-6} cm/sec and a longitudinal dispersion
coefficient of 3.6 X 10^{-6} cm²/sec, it will take about 6000 to 8000
years for the contaminant to break through the shallowest aquifer
in the region.   An estimate for 2 percent breakthrough of the
contaminant through a 3 ft. thick homogeneous barrier was esti-
mated to be greater than 50 years.

It is noted that these estimates are based upon laboratory hydraulic conductivity tests. Estimates should be updated using the given design charts with insitu hydraulic conductivity values.

Publications and Professional Presentations:

Acar, Y. B., Haider, L., and Edil, T. B., "Barrier Systems in Waste Disposal," Proceedings of the Third International Symposium on Environmental Management for Development Countries, Instanbul, Turkey, pp. 1-44, August 1986.

Acar, Y. B., D'Hollosey, E., "Assessment of Pore Fluid Effects Using Flexible Wall and Consolidation Permeameters," Proceedings of ASCE Specialty Conference on Geotechnical Practice in Waste Disposal, Ann Arbor, MI, pp. 234-245, June 14-18, 1987.

Haider, L., Acar, Y. B., "Transport of Low-Level Organic Leachates in Saturated Fine-Grained Earthen Barriers," to be submitted to Journal of Geotechnical Engineering (in preparation).

M. S. Theses:

Transport of Chlorinated Hydrocarbons in Saturated Cohesive Deposits of Southern Louisiana, Laique Haider, Louisiana State University, July 1987.

Ph.D. Dissertations: None

Training: This project trained one student who received M.S. degree in Civil Engineering with substantial background in geotechnical engineering and geology, with special emphasis on transport of contaminants.

INFORMATION TRANSFER ACTIVITIES

Information transfer activities for FY 1986 included initiating a newsletter, assembling an exhibit for an in-state conference, publishing articles in technical journals, and sponsoring a state-wide conference on water resources. These activities were initiated by staff members and/or research faculty. Faculty input included contributing articles and news items for the newsletter, preparing materials for the exhibit, coordinating publication of a conference proceedings, and writing journal articles. Highlights of each activity are given below.

The new Institute newsletter Louisiana Water Resources News was first published in January 1987. The newsletter, planned for publication three times per year, was distributed to persons working in or interested in water resources, and located throughout the state. Out of state individuals and organizations may request inclusion in the newsletter distribution. Content of the newsletters included articles describing the research activities of the Institute, feature articles on activities of state and federal agencies dealing with water resources, announcements of special events upcoming, and other news and announcements relevant to the state's water resources interests.

An exhibit was prepared for the Louisiana Water Pollution Control Association annual conference held in New Orleans on April 30 and May 1, 1987. The display highlighted water resources research supported by the Institute that addressed water quality issues.

The Institute was also a sponsor and active participant in another conference, Ground Water Protection in Louisiana, an annual conference sponsored by agencies and local companies concerned about ground water contamination. The conference was held in May 1987. The Institute's director served on the planning committee and coordinated the publication of the conference proceedings.

During the FY 1986 program, twenty-four technical journal articles were written and submitted for publication by the researchers. These article titles appear in the publication listing beginning on page 23.

Another significant activity for the Institute during FY 1986 was its five-year review by the U.S. Geological Survey Review Panel. Results of the review panel's evaluations indicated that the Institute is fostering relevant, high quality research. The Institute was, however, placed on probation until such time as deficiencies identified in the evaluation team's report can be overcome. Recommendations for overcoming these deficiencies included:

.   Reactivation of the State Advisory Board with a suitable
mix   representing   Government   and   private-sector   water
interests   to   set goals and priorities   for   the   Institute
program   and   to evaluate the relevance   of   annual   program
proposals to these goals,

.   Reactivation of the University Advisory Board to provide
the Director with guidance on research priorities and assis-
tance in technical evaluations of project proposals, and

.   Development   of an information transfer program that is
responsive   to   information   needs   of   Louisiana's   water
resources policymakers, managers and the public.

These items will be addressed in fiscal year 1987.

COOPERATIVE ARRANGEMENTS

The Louisiana Institute,   during the Fiscal Year 1986, began
efforts   to   develop cooperative research efforts with other   in-
state   agencies   and organizations.   The first evidence of   this
effort   was   the initiation of   a one-year   cooperative   research
project   with the Louisiana Department of   Environmental   Quality
(DEQ).

The   Institute received $48,632 to develop treatment   recom-
mendations for nontoxic biodegradable wastes produced by   seafood
processing   facilities   in the coastal zone   of   Louisiana.   The
project,   "Treatment   Options   for Louisiana Seafood ·Processors",
began   in   April 1987 and involves LSU faculty working   in   close
cooperation   with personnel from the DEQ's Technical Support   and
Permits Sections of the Division of Water Pollution Control.   Dr.
Ronald Malone,   LSU Department of Civil Engineering, is principal
investigator on the project that will run for one year, ending in
March 1988.

Other efforts to provide for state-wide participation in and
contribution   to   the   Institute's research program   include   the
inclusion   of key state water resources researchers and   managers
in   the   planning for and evaluation of   the   Institute's   annual
research program.   This is accomplished through participation in
the Institute's two advisory boards.

The University Advisory Board had six active members in   FY
1986.   These   members   represented   the   Departments   of   Civil
Engineering,   Agronomy,   Agricultural Economics,   Geography,   and
Forestry/Wildlife   and the Center for Wetlands Resources.

The   State Advisory Board had one active member in FY   1986,
with   other members' terms on the board   having   expired.   The

one active member of the State Advisory Board represented the Louisiana Department of Transportation and Development - Office of Public Works, an agency instrumental in planning and managing the state's water resources. Reactivation of this board is planned for FY 1987.

TRAINING ACCOMPLISHMENTS

Academic Disciplines	Academic Level				
	Under-graduate	Master's Degree	Ph.D. Degree	Post-Ph.D.	Total
Engineering - Agricultural - Civil - Environmental	3	4			7
Biology					
Ecology					
Fisheries, Wildlife and Forestry					
Agronomy					
Chemistry					
Hydrology		2	1		3
Resources Planning					
Law					
Economics					
Geography					
Other (specify)	2	1			3
TOTAL	5	7	1	0	13

Geology

LIST OF TECHNICAL PUBLICATIONS
Louisiana Water Resources Research Institute
Fiscal Year 1986

Acar, Y. B., Haider, L., and Edil, T. B., "Barrier Systems in
Waste Disposal," Proceedings of the Third International Symposium
on Environmental Management for Development Countries, Instanbul,
Turkey, pp. 1-44, August 1986.

Acar, Y. B., D'Hollosey, E., "Assessment of Pore Fluid Effects
Using Flexible Wall and Consolidation Permeameters," Proceedings
of ASCE Specialty Conference on Geotechnical Practice in Waste
Disposal, Ann Arbor, MI, pp. 234-245, June 14-18, 1987.

Haider, L., Acar, Y. B., "Transport of Low-Level Organic
Leachates in Saturated Fine-Grained Earthen Barriers," to be
submitted to Journal of Geotechnical Engineering (in
preparation).

Singh, V. P., "On Application of Weibull Distribution in
Hydrology." Water Resources Management, Vol. 1, No. 1, pp. 33-43,
1987.

Singh, V.P. and Rajagopal, A.K., "Some Recent Advances in Appli-
cation of the Principle of Maximum Entropy (POME) in Hydrology."
IAHS Publication No. 164, Proceedings, International Symposium on
Water for the Future, Rome, Italy, pp. 353-364, April 6-11,
1987.

Singh, V.P. and Singh, K., "Parameter Estimation for TPLN
Distribution for Flood Frequency Analysis." Water Resources Bul-
letin, in press, 1987.

Arora, K., and Singh, V.P.,"On Statistical Intercomparison of EV1
Estimators by Monte Carlo Simulation." Advances in Water Resour-
ces, Vol. 10, No. 2, pp. 87-107, 1987.

Singh, V.P. and Krstanovic, P.F., "A Stochastic Model for Sedi-
ment Yield Using the Principle of Maximum Entropy." Water Resour-
ces Research, Vol. 23, No. 5, 781-793, 1987.

Singh, V.P., "On the Extreme Value (EV) Type III Distribution for
Low Flows." Hydrological Sciences Journal in press, 1987.

Singh V.P. and Rajagopal, A. K., "A New Method of Parameter
Estimation for Hydrologic Frequency Analysis." Hydrological
Science and Technology: Short Papers, in press, 1987.

Arora, K. and Singh, V. P., A Comparative Evaluation of the
Estimators of Some Flood Frequency Models Using Monte Carlo

Simulation. Completion Report, Louisiana Water Resources Research Institute, Louisiana State University, Baton Rouge, Louisiana, 1987.

Fiorentino, M., Arora, K. and Singh, V.P., "The Two-Component Extreme Value Distribution for Flood Frequency Analysis: Another Look and Derivation of a New Estimation Method." Stochastic Hydrology and Hydraulics, Vol.__, No. __, pp. __. 1987.

Singh, V.P. and Singh, K., "Parameter Estimation for Log-Pearson Type III Distribution by POME", Journal of Hydraulic Engineering, ASCE, Vol.__, No.__, pp.__, 1987.

Singh, V.P., Rajagopal, A. K. and Singh, K.,"Derivation of Some Frequency Distributions Using the Principle of Maximum Entropy (POME)," Advances in Water Resources, Vol. 9, No. 2, pp. 91-106, 1986.

Jain, D. Singh, V.P., "A Comparison of Transformation Methods for Flood Frequency Analysis." Water Resources Bulletin, Vol. 22, No. 6, pp. 903-912, 1986.

Singh, V.P., "On the Log-Gumbel (LG) Distribution." Hydrology Journal of the IAH, Vol. VIII, No. 4, pp. 34-42, 1986.

Jain, D. and Singh, V. P., "Estimating Parameters of EV1 Distribution for Flood Frequency Analysis". Water Resources Bulletin, Vol. 23, No. 1, pp. 59-72, 1986.

Singh, V. P. and Krstanovic, P. F., A Multivariate Stochastic Flood Analysis Using Entropy. Completion Report, Louisiana Water Resources Research Institute, Louisiana State University, Baton Rouge, Louisiana, 1986.

Singh, V. P. and Krstanovic, P. F., "Space Design of Rainfall Networks Using Entropy." Proceedings, International Conference on Water Resources Needs and Planning in Drought Prone Areas, Khartoum, Sudan, December 6-12, 1986.

Cruise, J. F., "On the Application of the Poisson Partial Duration Flood Model," Journal of Hydrology (submitted).

Cruise, J. F., "The Application of the Poisson Partial Duration Model With a Log Pearson type III Distribution," (To be submitted to either Journal of Hydrology or Water Resources Bulletin).

Singhal, N., Sebuktekin, I., Roy, D., and Adrian, D. D., "A Study of Biodegradation of Pesticides in Soil," Proceedings of the International Symposium on Environmental Management, Istanbul, Turkey, June, 1987.

Sebuketin, I., Singhal, N., and Roy, D., "Effects of Mercury on the Biodegradation of 2,4-Dichlorophenoxy Acetic Acid (2,4-D) by Two New Pseudomonas Isolates," Presented before the Division of Environmental Chemistry, Annual Meeting of American Chemical Society, New Orleans, LA, August 30 - September 4, 1987.

Adrian, D. D., "Effect of Mercury Toxicity on the Biodegradation of Pesticides," Presented at Annual Meeting of Louisiana Water Pollution Control Association, New Orleans, April, 1987.

M. S. Theses

Transport of Chlorinated Hydrocarbons in Saturated Cohesive Deposits of Southern Louisiana, Laique Haider, Louisiana State University, July 1987.

A Comparative Evaluation of Methods of Frequency Analysis and Estimation of Parameters, D. Jain, Department of Civil Engineering, Louisiana State University, May 1986.

A Comparative Evaluation of Estimators of Commonly Used Flood Frequency Models, under preparation by K. Arora, Department of Civil Engineering, Louisiana State University, December 1986.

Effect of Heavy Metals on the Biodegradation of 2,4-D by Two New Pseudomonas Isolates. Isik Sebuktekin, Louisiana State University, August 1987.

Ph.D. Dissertations

Entropy Theory and its Application to Flood Analysis, under preparation by P. F. Krstanovic, Department of Civil Engineering, Louisiana State University, expected December 1987.