Statistical Analysis Of Groundwater Monitoring Data At

A Framework for Development of Data Analysis Protocols for Ground Water Quality Monitoring
Interim Final Guidance
Statistical Procedures for Analysis of Environmental Monitoring Data and Risk Assessment
Statistical Methods for Groundwater Monitoring
RCRA, TSCA, HMTA, OSHA, and Superfund
Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility, Interim Change Notice 1
Statistical Analysis of Ground-water Monitoring Data at RCRA (Resource Conservation and Recovery Act) Facilities, Interim Final Guidance
Groundwater Characterization, Management and Monitoring
Evaluation of an Alternative Statistical Method for Analysis of RCRA Groundwater Monitoring Data at the Hanford Site
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Statistical Methods for Groundwater Monitoring
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Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities
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Analysis of Groundwater Monitoring Data from Wongawilli, Dapto
Using Pre-Statistical Analysis to Streamline Monitoring Assessments
Statistical analysis of groundwater monitoring data from solid waste management facilities
Hydrogeologic Studies and Groundwater Monitoring in Snake Valley and Adjacent Hydrographic Areas, West-central Utah and East-central Nevada: report (304 pages), 4 Plates, Appendices and data tables
Unified Guidance
Ground-water Quality, Water Year 1995, and Statistical Analysis of Ground-water-quality Data, Water Years 1994-95, at the Chromic Acid Pit Site, U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso, Texas
Site Assessment and Remediation Handbook, Second Edition
Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities
Analysis of Censored Data in Groundwater Monitoring Wells at the Savannah River Site
Statistical Training Course for Ground-water Monitoring Data Analysis
Statistical Methods for Environmental Pollution Monitoring
Geospatial and Statistical Analysis of Anthropogenic Groundwater Contamination
The Complete Guide to the Hazardous Waste Regulations
No-Impact Threshold Values for NRAP's Reduced Order Models
Groundwater Monitoring Statistical Analysis
Introduction to Statistical Analysis of Laboratory Data

Addendum to Interim Final Guidance
Nondetects and Data Analysis
Interim Final Guidance

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A Framework for Development of Data Analysis Protocols for Ground Water Quality Monitoring John Wiley & Sons
In 2002, radium 226 and 228 measurements elevated above the 5 pCi/L groundwater protection standard (GWPS) and gross alpha measurements above the 15 pCi/L GWPS were noticed in several groundwater monitoring wells at the SRS Sanitary Landfill. An additional four quarters of confirmatory measurements for Ra in the SLF groundwater were taken during 2003 as directed by the SC Department of Health and Environmental Control. Elevated radium concentrations in groundwater of the Aiken County area are a common occurrence. Price and Michel (1990) compiled radium concentrations in drinking water wells of this area and showed several instances of the concentrations exceeding the regulatory limit. Ra226 is an alpha emitter and contributes much of the natural alpha radioactivity found in uncontaminated groundwater. Thus, the elevated radium concentrations are usually accompanied by elevated gross alpha concentrations. Appendix A2 indicates that this is the case at the SLF where Ra226 accounts for almost all elevated gross alpha.
Interim Final Guidance CRC Press
This book explains the statistical methods used to analyze the huge volume of data that groundwater monitoring wells produce in a comprehensive manner accessible to engineers and scientists who may not have a strong background in statistics. In addition, the book provides statistical methods to make the most accurate use of the data and shows how to set up an effective monitoring system.
Statistical Procedures for Analysis of Environmental Monitoring Data and Risk Assessment John Wiley & Sons
Introduction to Statistical Analysis of Laboratory Data presents a detailed discussion of important statistical concepts and methods of data presentation and analysis Provides detailed discussions on statistical applications including a comprehensive package of statistical tools that are specific to the laboratory experiment process Introduces terminology used in many applications such as the interpretation of assay design and validation as well as “fit for purpose” procedures including real world examples Includes a rigorous review of statistical quality control procedures in laboratory methodologies and influences on capabilities Presents methodologies used in the areas such as method comparison procedures, limit and bias detection, outlier analysis and detecting sources of variation Analysis of robustness and ruggedness including multivariate influences on response are introduced to account for controllable/uncontrollable laboratory conditions
Statistical Methods for Groundwater Monitoring WIT Press
STATISTICS IN PRACTICE Statistical methods for interpreting and analyzing censored environmental data Nondetects And Data Analysis: Statistics for Censored Environmental Data provides solutions for environmental scientists and professionals who need to interpret and analyze data that fall below the laboratory detection limit. Adapting survival analysis methods that have been successfully used in medical and industrial research, the author demonstrates, for the first time, their practical applications for studies of trace chemicals in air, water, soils, and biota. Readers quickly become proficient in these methods through the use of real-world examples that are solved using MINITAB® Release 14, a popular statistical software package, as well as other commonly used software packages. Everything needed to master these innovative statistical methods is provided, including: Accompanying Web site featuring answers to book exercises and datasets, as well as MINITAB® macros to perform methods, which are not available in the commercial version Methods for data with multiple detection limits Solutions for research studies in which all data are below detection limits Techniques for constructing confidence, prediction, and tolerance intervals for data with nond-tects Methods for data with multiple detection limits Chapters are organized by objective, such as computing intervals, comparing groups, and correlations, which enables readers to more easily apply the text to their particular research and goals. Extensive references to the literature for more in-depth research are provided; however, the text itself avoids complex math and calculus making it accessible to anyone in the environmental sciences. Environmental scientists and professionals will find the hands-on guidance and practical examples invaluable.
RCRA, TSCA, HMTA, OSHA, and Superfund CRC Press
"We use geospatial and statistical analysis to identify areas where there may be gaps in current legislation that protects aquifers and to identify anthropogenic contamination sources and pathways. Specifically, we focus on phosphorus (P) concentrations in groundwater and total dissolved solids (TDS) concentrations in groundwater in California. The results obtained from the analysis of these datasets can be used to guide sustainable water and ecosystem management policies and inform future groundwater monitoring efforts. Excess P in surface waters is a main driver of eutrophication, but P monitoring in groundwater is often overlooked because it was historically assumed that P is immobile in groundwater. To examine the risk P in groundwater poses to surface waters and ecosystems, we compile and analyze 161,321 groundwater P measurements from 12 different countries. We find that all 12 countries report groundwater P concentrations high enough to potentially cause ongoing or continued eutrophication in sur-face waters. Additionally, in Canada and the United States, we find that 93% of total P (TP) samples are found within 50 km of crop/pastureland. We also find a correlation between distance from the closest oil and gas well and elevated TP concentrations in the Canadian provinces of Alberta and Ontario. We focus on these provinces because there is a high density of oil and gas wells and of TP concentrations >0.1 mg P/L. These case studies indicate the need to further investigate the role of agriculture and oil and gas wells on groundwater impacts by P and other contaminants. The global da-ta synthesis shows that there are many data gaps limiting our ability to assess groundwater P contamination, including their sources and pathways. Understanding the sources and pathways for groundwater contamination is

important for sustainable groundwater management practices and protection. Total dissolved solids (TDS) concentrations represent minerals, salts, metals cations, or anions dissolved in water and is often taken as an indicator for overall ground-water quality. We use 216,754 total dissolved solids (TDS) concentration measurements in groundwater in California, United States, to examine the effectiveness of cur-rent groundwater legislation with respect to the base of fresh water (BFW), which is commonly used to identify the vertical extent to which aquifers are subject to ground-water management in the state. The definition for "fresh" water varies between regulating bodies but is generally taken to range from 1,000 to 3,000 mg/L. We analyze trends in the TDS dataset and find that we cannot estimate the BFW in 73% of California. We are able to estimate the BFW in 22% of the Central Valley, a key agricultural region with large groundwater demands and many critically overdrafted ground-water basins. Using a TDS limit of 3,000 mg/L, we estimate the shallowest BFW to be 155 m below ground surface in Kern County and the deepest BFW to be 589 m below ground surface in Stanislaus County. Our analysis demonstrates that geospatial and statistical analysis are useful for managing and analyzing groundwater contamination data. Specifically, there are opportunities for enhanced and strategic management and monitoring of groundwater, focusing on P and TDS. Currently, limitations in the availability of groundwater quality data make the delineation of usable groundwater and the extent of groundwater contamination challenging to identify. Moreover, implementing groundwater management that simultaneously considers and balances impacts of agricultural and oil and gas activities is needed. The results from this thesis can be used to design data-driven groundwater management programs and strategies that protect groundwater re-sources around the world"--

Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility, Interim Change Notice 1 Statistical Analysis of Groundwater Monitoring Data at RCRA FacilitiesUnified Guidance"The unified guidance provides a suggested framework and recommendations for the statistical analysis of groundwater monitoring data at RCRA facility units subject to 40 CFR Parts 264 and 265 and 40 CFR Part 258, to determine whether groundwater has been impacted by a hazardous constituent release." - - p. iii.Statistical Analysis of Ground-water Monitoring Data at RCRA FacilitiesInterim Final GuidanceGuidelineStatistical analysis of groundwater monitoring data from solid waste management facilitiesStatistical Methods for Groundwater Monitoring

A new edition of the most comprehensive overview of statistical methods for environmental monitoring applications Thoroughly updated to provide current research findings, Statistical Methods for Groundwater Monitoring, Second Edition continues to provide a comprehensive overview and accessible treatment of the statistical methods that are useful in the analysis of environmental data. This new edition expands focus on statistical comparison to regulatory standards that are a vital part of assessment, compliance, and corrective action monitoring in the environmental sciences. The book explores quantitative concepts useful for surface water monitoring as well as soil and air monitoring applications while also maintaining a focus on the analysis of groundwater monitoring data in order to detect environmental impacts from a variety of sources, such as industrial activity and waste disposal. The authors introduce the statistical properties of alternative approaches, such as false positive and false negative rates, that are associated with each test and the factors related to these error rates. The Second Edition also features: An introduction to Intra-laboratory Calibration Curves and random-effects regression models for non-constant measurement variability Coverage of statistical prediction limits for a gamma-distributed random variable, with a focus on estimation and testing of parameters in environmental monitoring applications A unified treatment of censored data with the computation of statistical prediction, tolerance, and control limits Expanded coverage of statistical issues related to laboratory practice, such as detection and quantitation limits An updated chapter on regulatory issues that outlines common mistakes to avoid in groundwater monitoring applications as well as an introduction to the newest regulations for both hazardous and municipal solid waste facilities Each chapter provides a general overview of a problem, followed by statistical derivation of the solution and a relevant example complete with computational details that allow readers to perform routine application of the statistical results. Relevant issues are highlighted throughout, and recommendations are also provided for specific problems based on characteristics such as number of monitoring wells, number of constituents, distributional form of measurements, and detection frequency. Statistical Methods for Groundwater Monitoring, Second Edition is an excellent supplement to courses on environmental statistics at the upper-undergraduate and graduate levels. It is also a valuable resource for researchers and practitioners in the fields of biostatistics, engineering, and the environmental sciences who work with statistical methods in their everyday work.

Statistical Analysis of Ground-water Monitoring Data at RCRA (Resource Conservation and Recovery Act) Facilities, Interim Final Guidance CRC Press

This form updates the groundwater monitoring plan for the B Pond system and documents revision agreed upon with the Washington State Department of Ecology concerning well network, constituent list, statistical analysis, and report procedures.

Groundwater Characterization, Management and Monitoring John Wiley & Sons

Statistical methods are required in groundwater monitoring programs to determine if a RCRA-regulated unit affects groundwater quality beneath a site. This report presents the results of the statistical analysis of groundwater monitoring data acquired at B Pond and the 300 Area process trenches during a 2-year trial test period.

Evaluation of an Alternative Statistical Method for Analysis of RCRA Groundwater Monitoring Data at the Hanford Site Elsevier

The purpose of this study was to develop methodologies for establishing baseline datasets and statistical protocols for determining statistically significant changes between background concentrations and predicted concentrations that would be used to represent a contamination plume in the Gen II models being developed by NRAP's Groundwater Protection team. The initial effort examined selected portions of two aquifer systems; the urban shallow-unconfined aquifer system of the Edwards-Trinity Aquifer System (being used to develop the ROM for carbon-rock aquifers, and the a portion of the High Plains Aquifer (an unconsolidated and semi-consolidated sand and gravel aquifer, being used to development the ROM for sandstone aquifers). Threshold values were determined for Cd, Pb, As, pH, and TDS that could be used to identify contamination due to predicted impacts from carbon sequestration storage reservoirs, based on recommendations found in the EPA's "Unified Guidance for Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities" (US Environmental Protection Agency 2009). Results from this effort can be used to inform

a "no change" scenario with respect to groundwater impacts, rather than the use of an MCL that could be significantly higher than existing concentrations in the aquifer.

Statistical Methods for Groundwater Monitoring Wiley-Interscience

This book discusses a broad range of statistical design and analysis methods that are particularly well suited to pollution data. It explains key statistical techniques in easy-to-comprehend terms and uses practical examples, exercises, and case studies to illustrate procedures. Dr. Gilbert begins by discussing a space-time framework for sampling pollutants. He then shows how to use statistical sample survey methods to estimate average and total amounts of pollutants in the environment, and how to determine the number of field samples and measurements to collect for this purpose. Then a broad range of statistical analysis methods are described and illustrated. These include: * determining the number of samples needed to find hot spots * analyzing pollution data that are lognormally distributed * testing for trends over time or space * estimating the magnitude of trends * comparing pollution data from two or more populations New areas discussed in this sourcebook include statistical techniques for data that are correlated, reported as less than the measurement detection limit, or obtained from field-composited samples. Nonparametric statistical analysis methods are emphasized since parametric procedures are often not appropriate for pollution data. This book also provides an illustrated comprehensive computer code for nonparametric trend detection and estimation analyses as well as nineteen statistical tables to permit easy application of the discussed statistical techniques. In addition, many publications are cited that deal with the design of pollution studies and the statistical analysis of pollution data. This sourcebook will be a useful tool for applied statisticians, ecologists, radioecologists, hydrologists, biologists, environmental engineers, and other professionals who deal with the collection, analysis, and interpretation of pollution in air, water, and soil.

Statistical Analysis of Elevated Radium and Gross Alpha Measurement in the Sanitary Landfill Wiley-Interscience

"The unified guidance provides a suggested framework and recommendations for the statistical analysis of groundwater monitoring data at RCRA facility units subject to 40 CFR Parts 264 and 265 and 40 CFR Part 258, to determine whether groundwater has been impacted by a hazardous constituent release." - - p. iii.

The Essential Handbook of Ground-Water Sampling Utah Geological Survey

Due to the increasing demand for adequate water supply caused by the augmenting global population, groundwater production has acquired a new importance. In many areas, surface waters are not available in sufficient quantity or quality. Thus, an increasing demand for groundwater has resulted. However, the residence of time of groundwater can be of the order of thousands of years while surface waters is of the order of days. Therefore, substantially more attention is warranted for transport processes and pollution remediation in groundwater than for surface waters. Similarly, pollution remediation problems in groundwater are generally complex. This excellent, timely resource covers the field of groundwater from an engineering perspective, comprehensively addressing the range of subjects related to subsurface hydrology. It provides a practical treatment of the flow of groundwater, the transport of substances, the construction of wells and well fields, the production of groundwater, and site characterization and remediation of groundwater pollution. No other reference specializes in groundwater engineering to such a broad range of subjects. Its use extends to: The engineer designing a well or well field The engineer designing or operating a landfill facility for municipal or hazardous wastes The hydrogeologist investigating a contaminant plume The engineer examining the remediation of a groundwater pollution problem The engineer or lawyer studying the laws and regulations related to groundwater quality The scientist analyzing the mechanics of solute transport The geohydrologist assessing the regional modeling of aquifers The geophysicist determining the characterization of an aquifer The cartographer mapping aquifer characteristics The practitioner planning a monitoring network

The Handbook of Groundwater Engineering John Wiley & Sons

"A very well-written handbook." --Ground Water (on the Second Edition) "Presented in a very readable and understandable format." --The Hazardous Waste Consultant (on the Second Edition) The foremost in-depth survey of federal hazardous waste regulations in the United States--now in a new edition The Complete Guide to the Hazardous Waste Regulations is a proven source of clear information on a regulatory system that many find frustratingly complex. Now updated to include additional compliance checklists, Internet resources, and more, this Third Edition provides vital information on all aspects of hazardous materials, from proper on-site management and transportation to appropriate off-site management and cleanup. Author Travis Wagner, one of the nation's leading experts on the subject, provides a step-by-step approach to compliance that goes beyond summarization to help industry professionals truly understand regulations and how they relate to real-world situations. Complete with dozens of user-friendly checklists, flow charts, text boxes, and tables, this indispensable resource includes: * Information on EPA interpretations of regulations not included in other handbooks * Clear explanations of many state-level hazardous waste requirements * A new chapter on spill reporting, giving a step-by-step explanation with attention to multiple federal laws * An appendix listing the Superfund and EPCRA reportable quantity for each RCRA hazardous waste * Additional appendices covering RCRA hazardous wastes, hazardous constituents, groundwater monitoring constituents, permit modification classifications, additional information sources, and important acronyms

Statistical Analysis of Rare Events in Groundwater Prentice Hall

This report (269 pages, 4 plates) presents hydrogeologic, groundwater-monitoring, and hydrochemical studies by the Utah Geological Survey (UGS) in Snake Valley, Tule Valley, and Fish Springs Flat in Millard and Juab Counties, west-central Utah. Data From the newly established UGS groundwater-monitoring network establish current baseline conditions, and will help quantify the effects of future variations in climate and groundwater pumping. New hydrochemical data show that groundwater quality is generally good, major-solute chemistry varies systematically from recharge to discharge areas, and suggest that most groundwater was recharged over one thousand years ago, implying low recharge rates and/or long or slow flow paths. Two aquifer tests yield estimates of transmissivity and storativity for the carbonate-rock and basin-fill aquifers. Variations in the potentiometric surface, hydrogeology, and hydrochemistry are consistent with the hypothesis of regional groundwater flow from Snake Valley northeast to Tule Valley and Fish Springs. Collectively, our work delineates groundwater levels, flow, and chemistry in Snake Valley and adjacent basins to a much greater degree than previously possible, and emphasizes the sensitivity of the groundwater

system to possible increases in groundwater pumping.

2101-M Pond Hydrogeologic Characterization Report John Wiley & Sons

Tremendous improvements in ground-water sampling methodologies and analytical technologies have made it possible to collect and analyze truly representative samples to detect increasingly lower levels of contaminants-now in the sub-parts-per-billion range. Though these new methods produce more accurate and precise data and are less expensive, many

Statistical Approaches to Groundwater Monitoring

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Statistical Methods for Groundwater Monitoring

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Guidance Document on the Statistical Analysis of Ground-water Monitoring Data RCRA Facilities

For students and professionals in environmental, civil, and mechanical engineering, few tasks are as challenging as statistical analysis and interpretation. In this book, two leaders in the field address these challenges head-on. They introduce each leading statistical analysis technique, downplaying mathematical notation in favor of sample environmental applications and explanations that make sense to non-statisticians. They also address common problems in data interpretation: small data sets; the need to correlate constituents to infill missing data or identify outliers; creating early warning systems with fewer "false positives," handling noise, and assessing risk. Coverage includes: Characterizing environmental quality data with Normal, Lognormal, and other distributions. Characterizing coincident behavior using regression, correlation and multiple regression. Multiple comparisons using ANOVA and associated parametric analysis techniques. Testing differences between monitoring records when censored data records exist. Focuses on "real-world" situations where data sets may be imperfect. Reflecting decades of experience in the field, the authors also show how to use statistical analysis as the input to realistic risk assessment. In particular, they demonstrate simulation procedures for risk characterization, using sampling methodologies from probability distributions of data. Whether you are concerned with issues of air quality, surface water, groundwater, or soil contamination, the techniques covered in this book will be invaluable.

Statistics for Censored Environmental Data

It is common in environmental analyses to deal with censored data. Censored data characteristically arise through laboratory analysis of samples with contaminant concentrations less than what the analytical method is able to reliably detect. These data are called ''less than detectable.'' Comparisons between downgradient or monitoring groundwater wells and upgradient or background wells are frequently done to determine if downgradient wells are more contaminated than background or some established maximum concentration limits (MCL's). In addition, parameter estimates are often desired. The presence of censored data complicates the statistics that can be used as estimators for individual populations or to estimate differences between two populations. This paper describes the current process at Savannah River Site (SRS) to determine constituents of concern (COC's) for complying with groundwater monitoring and clean-up regulations. COC's are analytes found in downgradient monitoring wells in concentrations significantly greater than in background wells or significantly greater than the MCL'S. Both parametric and non-parametric statistics are explored. Data plots are examined for outliers, trends, laboratory or sampling contamination, and unusually large detection limits for censored results. Wells are grouped by similar concentration levels to form a ''characteristic'' well, improving the estimation and decision process.

Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities

This title addresses the theoretical background necessary to accomplish planning and management of groundwater systems, and presents up-to-date applications of the decision-aid techniques in this field.

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