GoldSim User Conference 2024

Presentation Abstracts and Bios

## GoldSim: Looking Back Over the Last 20+ Years

**Author:** Rick Kossik (GoldSim Technology Group)

Rick is the President and co-founder of the GoldSim Technology Group. He has a BS from the University of Michigan and an MS from the Massachusetts Institute of Technology. He has spent most of his career developing and applying probabilistic simulation techniques to evaluate environmental systems. Starting in 1990, he began working with his colleagues on the development of GoldSim and its precursor, RIP. He is the primary author of the GoldSim documentation and the online courses.

**Abstract**

Although the GoldSim Technology Group as a company is 20 years old, the GoldSim software itself actually has its origins in the late 1980s. This talk will look all the way back to these origins and touch on some of the key milestones in its development, culminating in a tool that is currently used in over 60 countries worldwide with thousands of users.

## Overview of GoldSim-Based Modeling Applications to Support Environmental Decisions at the Hanford Site, Washington, USA

**Author:** Sunil Mehta (Intera)

Sunil Mehta is a hydrogeologist and geochemist with three decades of experience in the areas of environmental remediation, reactive transport modeling, and performance assessment. After completing his Ph.D. from University of Kentucky in 2000 he joined the Total System Performance Assessment group at the Yucca Mountain Project, the proposed high-level nuclear waste repository, and was the technical lead for modeling the engineered barrier system. Since 2009 he has been leading projects on environmental remediation at the Hanford Site. Dr. Mehta manages teams of scientists and engineers, provides technical guidance and leadership, and presents results to management, clients, and other stakeholders.

**Abstract**

The environmental restoration and remediation activities at the Department of Energy’s Hanford Site located in the southeastern portion of the Washington, USA, are currently underway following change in Hanford site mission in 1989 from nuclear weapon material production to site clean-up. Over the past two decades several environmental modeling/calculations have been performed using a variety of modeling software, including GoldSim, to support the complex decisions under the current regulatory framework (Hanford Tri-Pary Agreement). The focus of the talk will be to provide an overview of the GoldSim based calculations/applications over the past 15 years in supporting environmental decisions at Hanford. The applications range from conducting probabilistic performance assessments of radioactive waste disposal facilities and underground tanks with residual contamination, developing historic liquid discharge inventory estimates for hundreds of waste sites, performing contaminant transport modeling in the aquifer, development of preliminary remediation goals for soil concentrations, performing geochemical and reactive transport modeling, and conducting thermal modeling.

# The 20-year Evolution of GoldSim for Water Resource Management: An Australian Perspective

**Author:** Jan Vermaak (Groundwater Resource Management)

Dr. Jan Vermaak is a hydrogeologist and water management specialist at Groundwater Resource Management, a Perth-based consulting company in Australia. With a career spanning 26 years, Jan has gained experience in Australia, Africa, and Southeast Asia. His role involves assisting clients with the management of groundwater and surface water resources, with a focus on the mining industry. Additionally, Jan assists with water supply investigations, water related environmental assessments and water infrastructure designs.

Jan was one of the first GoldSim users in Australia and is delighted to be back in Seattle, having attended the 2003 conference. He looks forward to learning more about GoldSim’s applications and attending the baseball game.

**Abstract**

GoldSim has emerged as an integral component in the effective management of water resources linked to primary industries. This presentation offers a comprehensive overview of GoldSim's applications in diverse water-related investigations, encompassing water supply assessments, water management strategies, and regulatory considerations, with a specific focus on the Australian mining industry. The presentation delves into the historical impact of GoldSim over the past two decades, highlighting its evolution into a cornerstone software. Its applications span surface water resource assessments, risk evaluations, and assistance with various regulatory requirements, including water accounting frameworks, compliance with the cyanide code, and studies related to post-closure pit lakes.

# Model Complexity

**Author:** David Esh (US Nuclear Regulatory Commission)

David has been a GoldSim modeler since it was offered to the public in 2002. He has used it to author thousands of GoldSim models ranging from simple to extremely complex. He has worked for the Nuclear Regulatory Commission for 25 years in the areas of radioactive waste disposal and complex site decommissioning. Prior to that he worked for Argonne National Laboratory on advanced nuclear technologies applied to the back end of the nuclear fuel cycle.

David luckily found a wife who will tolerate him, has two daughters at universities less prestigious than the University of Michigan, and two goldendoodles. David has four degrees, including a PhD in environmental engineering. Three of these degrees are from Pennsylvania State University where he excelled in classwork on the properties, development, and use of smokeless tobacco. His favorite class was BOVPHYS 410, the physics and dynamics of cow tipping. His university is currently on a three game losing streak to Big Ten power Michigan because Penn State has refused to use technology to steal signs in order to gain a competitive advantage. In his spare time he enjoys fly fishing, weightlifting, slowpitch softball, and collecting 8 bit computers.

**Abstract**

Modeling is frequently an essential component of the scientific process. Models are used for many different purposes, from providing input to decisions to developing understanding about a system. Model complexity can take many different forms. The types of complexity include but are not limited to complexity in scope (e.g., breadth, depth), spatial and temporal scales and variability, and the types of couplings, interactions, and responses of the system being evaluated. Though some models may need to cover large spatial and temporal scales, complexity of scale is generally most significant when short- and long-term or small and large spatial scale phenomena must be included in the same model. Some very large models (computationally) may be relatively simple in terms of model response whereas some small models can be very complex. This presentation discusses the types of complexity that may be encountered in a modeling project and considerations when using GoldSim to model these systems. GoldSim has many features that are very useful when modeling complex systems. General examples are provided facilitate understanding of the concepts presented.

# Using GoldSim in a Decision Analysis Framework

**Authors:** Paul Black, Tom Stockton, David Brown, Paul Duffy, Katie Catlett, Ralph Perona, and Sean McCandless at Neptune and Company, Inc.

Paul Black received his PhD from Carnegie Mellon University in Bayesian statistics, and hence has applied that same philosophy and thinking to solving complex problems, including those of what to do with nuclear or radioactive waste. Paul is the remaining co-founder of Neptune and Company, an environmental consulting company formed in 1992. Since 1995 Neptune has been involved in Performance Assessments (PAs) for DOE and commercial facilities, and even some international facilities. Paul’s background in statistics and decision analysis helped to bring a different perspective to low-level waste PAs, which had previously been performed deterministically and conservatively, which mostly means leading to poor decision making. The advent of GoldSim allowed Paul and the Neptune team to take a substantially different, and appropriate approach so that more effective decisions could be made for radioactive waste, and hence some support for the nuclear industry could be provided. Neptune has used GoldSim since its inception, and even RIP prior to that.

**Abstract**

Neptune has been engaged in the long-term probabilistic performance assessment (PPA) for the DOE West Valley site in western New York State for the past decade. Radioactive waste was interred at this site during operations in the 1970s and 1980s, and decisions need to be made about its long-term future. Although this is one of DOE’s smaller sites, it is arguably one of the more complex both from a technical and regulatory perspective. More than 400 decision units (DUs) have been identified ranging from trenches to deep holes to underground tanks. Neptune has developed a PPA model in GoldSim that covers all the DUs, however, the next step is to decide which DUs need to be exhumed, which need to remain in place, and what type of cover is needed for those that remain in place. These decisions are based on considerably more than regulatory compliance. They are also based on other attributes that are important to the decision-making process. These attributes loosely follow from a list contained in NRC’s NUREG 1757 Appendix N as low as reasonably achievable (ALARA) guidance, including benefits such as averted dose, regulatory costs avoided, changes in land values, aesthetics, and public acceptance, and costs such as those from remediation, worker safety, non-radiological risks, and environmental impacts. Neptune is using the results from the PPA model in GoldSIm that includes radiological doses, and human health and ecological risk from chemical exposure, together with information on the other costs and benefits, and is building a comprehensive decision model in its GiSdT (Guided Interactive Statistics and Decision Tools) software. This approach of interfacing the GoldSIm results with other attributes in GiSdT will be used to determine which DUs need to be exhumed and which can remain in place.

# Multiple Cooks in the Kitchen: Lessons Learned from Successful Navigation of a Multi-Contributor GoldSim Modeling Project

**Authors**: Paul Haby (presenter), Steve Byers, Alyssa Seal, Dan Walker at WSP

****Paul is a senior water resources consultant with WSP and is based in Fort Collins, Colorado. He has over 20 years of experience specializing in mine water management and the development of water balance and water quality simulation models for the mining industry. These models facilitate the understanding and analysis of dynamic water management and water-quality processes and are used to support feasibility studies, environmental permitting, operations optimization, and mine closure planning activities. Representative projects include the simulation of water quality impacts on the receiving environment from mine sites, tailings storage facility water and material balances for operations and risk assessment, pit lake hydrology and water quality predictions, and site-wide water and chemical mass balance models. Paul is a Certified GoldSim Training Provider and regularly provides GoldSim training and model development guidance to WSP personnel and external clients.

**Abstract**

A case study will be presented highlighting the approach utilized and lessons learned while navigating the development of a GoldSim-based water and mass balance model with three primary model contributors. WSP provided project coordination and model integration standards, as well as the overall site-wide model framework, which included model input and downstream receiving environment components. Two major model components were developed by non-WSP model contributors for integration into the site-wide model. Model inputs such as site climate monitoring data, water quality source terms, and downstream receiving environment assessment guidelines were provided by other non-WSP model contributors. To coordinate model development activities across the various model contributors and streamline model integration, WSP provided model contributors with a model design guidance document, which served as a common blueprint for the coordinated development and integration of model components.

The approach developed for this project allowed for concurrent development of model components with seamless drop-in replacement of model components as updates became available. In addition to projects with multiple external model contributors, this model development approach and the lessons learned from this case study could also be applied to in-house model development projects that require parallel development of multiple components.

# Supporting Arizona Water Management in an Era of Limits

**Author:** Ken Seasholes (Central Arizona Project)

****Ken Seasholes is the manager of Resource Planning & Analysis for the Central Arizona Project (CAP). His group has responsibilities for long-range planning and policy analysis within CAP's three-county service area, which includes the Phoenix and Tucson metropolitan areas along with seven Tribal reservations and more than 300,000 irrigated acres. Since joining CAP in 2008, Ken has contributed to a range of initiatives, including allocation of CAP water, water banking, exchanges, Colorado River shortage modeling, the use of the CAP infrastructure to transport new water supplies. Before joining CAP, Ken was the Tucson Area Director for the Arizona Department of Water Resources, and prior to that was a researcher at the Water Resources Research Center at the University of Arizona. Ken has a Master’s degree in Geography and a Bachelor’s degree in Political Science.

**Abstract**

Water managers in Arizona are currently grappling with two profound challenges--new limits on groundwater to support growth, and reduced access to Colorado River water. The Central Arizona Project (CAP), which delivers Colorado River water to 80% of Arizona’s population, is extensively involved with both issues.

To provide planning and policy support, staff at CAP rely on a variety of tools, including custom-built GoldSim models. In this presentation models at three geographic scales are discussed--a rapidly developed model comparing reductions among Colorado River Basin states; a complex regional model that simulates the supplies and demands of 100 water providers, tribes, and agricultural districts; and a neighborhood-scale model that simulates the growth and water use of 1,300 subdivisions and 265,000 residential lots.

These models differ substantially in their size and scope, but they share a common style that emphasizes the flow of information and discrete calculation steps. This modeling approach has helped CAP adapt in the face of changing policies, deep uncertainty and increasing complexity.

# Simulating the Uncertainty of Climate Change in Water Balance Models

**Author:** David Hoekstra (SRK)

David Hoekstra is water resource engineer with a civil engineering background and over 35 years of experience in mining, environmental, solid waste, oil and gas, and geotechnical projects. He has extensive experience in mine water management, mine closure projects, design of surface water conveyance and stormwater structures, design of water storage structures for surface water and solution flows, and hydrologic studies. He has also been developing probabilistic, dynamic water balances for mine sites for most of his career, using a variety of tools such as Excel, OpSim, and GoldSim to simulate the management of process solutions, AMD, runoff, and groundwater flows for a wide variety of mining projects, from coal to precious metals and from prefeasibility to operational and closure facilities. Mr. Hoekstra first became involved in GoldSim simulation software during the early development of the tool in the late 90’s and has been an intensive user of it for over 25 years. He has developed and presented several short courses covering tailings and mine water balances and the use of GoldSim to develop mine water balance models.

**Abstract**

Mine site water balances in GoldSim are considered the ‘de facto’ standard for dynamic, high resolution, probabilistic simulations for conceptual and operational mine water management systems. Many of these models are projected well out into the future to simulate conditions during long-term closure of the mine. Industry standards often require the water balance to incorporate probabilistic components and include the impacts of climate change on the system.

By stochastically simulating the climate, including climate change prediction scenarios, and incorporating realistic responses to environmental conditions, the GoldSim mine water balance can simulate the systems response to weather (which is what we get), as opposed to climate (which is what we expect) out to the end of the century, though with a large cloud of uncertainty surrounding the results.

This presentation will focus on:

* Exploring the key assumptions used in climate change predictions, including ‘how hot will the planet get?’ (Representative Concentration Pathways or RCPs), and ‘how will society respond to changing climate?’ (Shared Socioeconomic Pathways or SSP’s).
* How SRK uses around 30 different Global Climate Models (GCM’s) to quantify the cloud of uncertainty around climate change predictions.
* Incorporating the uncertainties inherent in climate change models into a consistent stochastic time frame instead of just selecting the mean change in climate.
* Show how SRK uses a variant of the WGEN synthetic climate generator to simulate the uncertainty of day-to-day weather as well as the long-term climate change trends predicted by the Intergovernmental Panel on Climate Change (IPCC).

# A Climate-Informed Reservoir Operation Model

**Author:** Anita Johnson (LRE Water)

Anita Johnson has 30+ years of professional experience in hydrology and mine water management. Anita is an expert in mine water management and industrial process water optimization. This draws on her skills in combining the technical aspects of water modeling with the softer skills involving stakeholder engagement, coordinating mine departments’ water needs, and developing and integrating a broad understanding of the entire operation’s water issues. She designs and builds GoldSim mine water balance models to meet the specific and/or general needs of mining clients from feasibility to permitting, through operations, and to prepare for, and implement closure. She is experienced in the design and implementation of groundwater investigations and development of water management systems for a variety of sites, primarily mine related. She has extensive aquifer testing experience including design, implementation and analysis, and provides peer review on these subjects. Anita has project experience on all continents, in a wide variety of climatic and hydrologic conditions, and mine types.

**Abstract**

This model represents a typical watershed in Colorado. It includes a reservoir that fills with runoff from two upgradient catchments. Demands on the reservoir include maintenance of a minimum downstream flow rate to support aquatic life and several seasonal agricultural water supplies. In addition to these, recreational water releases can be made under certain conditions to increase downstream flow for rafting and kayaking.

This model uses PrecipGen to create a realistic, stochastic, catchment-specific, synthetic precipitation data for the future based on long-term historical measured precipitation. Synthetic precipitation data, together with other climatic and hydrological data are used to simulate water captured by the reservoir using the Australian Water Balance Model. GoldSim's pool and allocator elements are used to track water storage and manage reservoir demands. Climate change scenarios are represented using alternative synthetic PrecipGen data generated using measured data coupled with statistics associated with selected publicly-available climate change models to evaluate the future vulnerability of aquatic life, water rights and recreational activities.

# GoldSim: The Next 20 Years

**Author:** Jason Lillywhite (GoldSim Technology Group)

Jason specializes in hydraulic and hydrologic modeling for water resources infrastructure. He began his career as a consultant at CH2M, where he worked on municipal water delivery systems, irrigation canal improvements, and flood control studies. In recent years, Jason has been with GoldSim, providing advanced technical support for conceptual water supply and industrial water balance models. He has a keen interest in simulating hydrological processes for decision support, particularly in systems involving uncertainty and forecasting the impacts of climate change. Jason holds an MS in civil and environmental engineering from the University of Utah.

**Abstract**

In this presentation, we will introduce GoldSim 15, our latest version designed to address complex engineering challenges. GoldSim 15 includes enhanced capabilities and a new element for modeling flow controls. As we look ahead, the need for models that address uncertainty is growing, enabling engineers to make informed decisions amidst unpredictable variables. GoldSim is equipped to meet these demands, offering robust tools for simulating and analyzing diverse engineering problems. We anticipate increased use of GoldSim in the water and energy sectors as these areas face growing demands and environmental changes, necessitating a deeper understanding of their impact on natural systems.

As technology evolves, so does the workflow of modeling. Engineers are now working with data and algorithms at a higher level, a trend that aligns with GoldSim’s strengths. Our platform supports this shift with a user-friendly, visual interface that simplifies complex modeling tasks. Looking forward, GoldSim will continue to evolve, ensuring it remains at the forefront of addressing environmental challenges that require the incorporation of uncertainty into models. Our commitment to providing responsive, knowledgeable support and maintaining an intuitive interface will remain steadfast. Join us as we explore the future of GoldSim and its role in solving tomorrow’s engineering problems.