



GoldSim

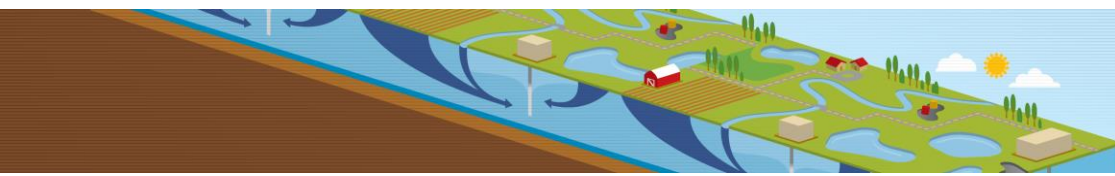
Using GoldSim and Dynamic Simulation to Support Integrated Water Resources Management

White Paper

Abstract

Rising demand for scarce water resources is a growing concern for water managers and utilities who have struggled to provide sustainable solutions for their customers. Integrated water resources management (IWRM) is a framework that supports collaboration and fosters proactive decision-making for efficient management of water resources. GoldSim is a dynamic simulation software tool that has successfully provided support for the IWRM process on multiple projects.

GoldSim is a powerful and flexible Windows-based computer program for carrying out probabilistic simulations of complex systems to support management and decision-making in engineering, science and business. The program is highly graphical, highly extensible, able to directly represent uncertainty, and allows you to create compelling presentations of your model. Although GoldSim can be used to solve a wide variety of complex problems, it is particularly well-suited to integrated water resources management applications. In particular, it allows you to create realistic models of water resources systems in order to carry out risk analyses, evaluate potential environmental impacts, support strategic planning, and make better management decisions. It has been used by customers around the world for water and waste management studies, to support environmental compliance and permitting, for watershed planning, and water supply and demand forecasting. This paper provides a brief overview of GoldSim, with special emphasis on integrated water resource management applications





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Introduction

Rising demand for scarce water resources is a growing concern for water supply managers and utilities who have struggled to provide sustainable solutions for their customers. It is estimated that currently one third of the world's population lives in countries that experience medium to high water stress. This ratio is expected to grow to two thirds by 2025 (GWP, 2000). Water use has been increasing at more than double the rate of population growth in the past 100 years (UN-Water, 2010). In addition to an overall increase in water demand, the world today faces a wider variety of competing demands, including agricultural, municipal, industrial, energy, environmental, and recreational. These challenges are amplified by shortcomings in management of water resources.

Integrated Water Resources Management

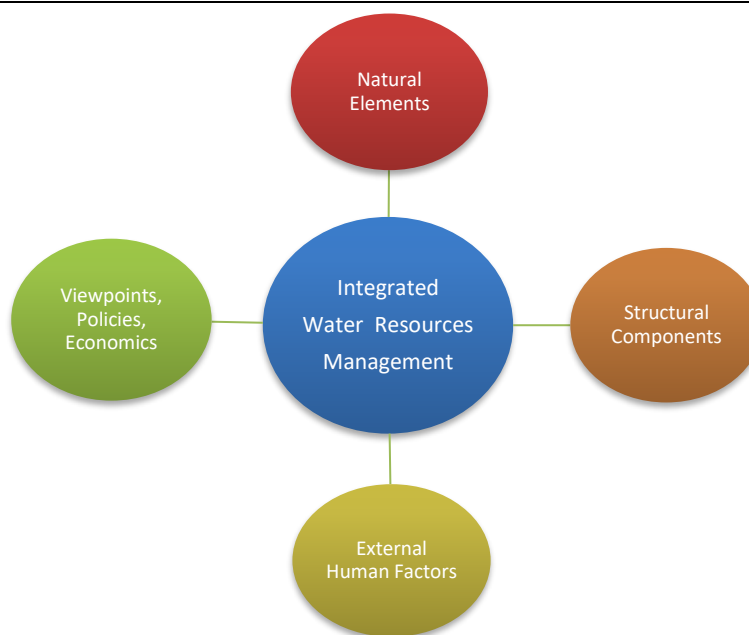
Integrated Water Resources Management (IWRM) is a decision making and planning strategy that brings together multiple facets of the water cycle such as water supply, water treatment, demand management, and wastewater/stormwater management. Multiple facets are brought into consideration in order to use our scarce water resources in a sustainable manner. The IWRM strategy has been loosely defined as “a process, which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems,” with emphasis on management within a basin-wide context, under the principles of good governance and public participation (WSSD, 2002).

The IWRM strategy differs from many traditional management approaches in that it involves stakeholders throughout the planning process, and it emphasizes an iterative, adaptive approach.

The IWRM framework is driven by the four main components shown in Figure 1¹:

- **Natural elements:** forces of nature, boundary conditions, independent variables, hydrology
- **Structural components:** reservoirs, pumps, treatment plants, canals, operational logic
- **Viewpoints, policies, economics:** stakeholder input, water rights, cost-benefit data
- **External Human Factors:** competing water demands, environmental policy, upstream flow controls

¹ Based loosely on the definition provided by others (Grigg, 1996; Pacific Islands Applied Geoscience Commission; Federal Ministry of Education, 2010; Mekong River Commission, 2010).

Figure 1. IWRM framework.

Using Simulation to Support Integrated Water Resource Management

Simulation models play an important, if not leading role in the IWRM process. In addition to predicting the future state of the system, models are used for exploration, communication, and analysis. As such, these models can be useful for the decision making process where conflict resolution, negotiation, and dialogue are key. Not only has the demand for water intensified but the complexity of evaluating water management schemes has also made it more difficult to plan for the future. Simulation in this context presents a powerful tool for analyzing different options and understanding the long-term implications of management decisions.

Simulation modeling frameworks that support IWRM should be tied to the four main categories illustrated in Figure 1. The model should encapsulate the natural elements and structural components while integrating the key policies, stakeholder viewpoints, and external human factors. It has been recognized that there is a strong interdependency between these categories, and it is therefore important to effectively coordinate these interdependencies within a modeling framework (Rosbjerg & Knudsen, 1983).

Water management practitioners are faced with increasing uncertainty due, for example, to changes in the human dimension and climate change (NeWater, 2007). Management strategies must be robust and efficient under a wide range of uncertain future developments. Models can be used to simulate various scenarios, and explicitly represent these kinds of uncertainties.

Finally, communication is key when a broad stakeholder audience becomes involved in a project. A modeling tool can help incorporate various perspectives and provide better visualization of how water supplies and demands vary in the system over time, including any feedbacks that might cause unexpected changes in other parts of the system. This type of feedback is often difficult to understand and explain without a model.

Hence, within the IWRM framework, modeling can play a key role in providing a unique opportunity to facilitate stakeholder involvement and supporting consensus

building by providing a tool to simulate the long-term effects of management strategies and decisions in uncertain and complex systems.

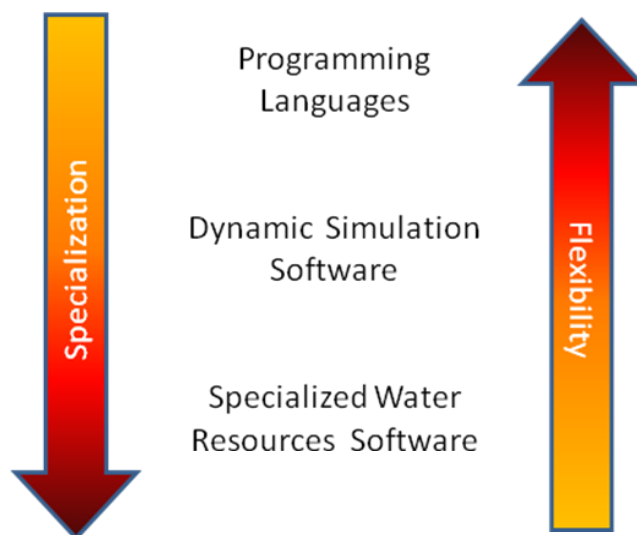
Modeling Approaches for Integrated Water Resources Management

In this section, the main categories of simulation modeling approaches for IWRM are introduced, compared and contrasted.

Categories of Simulation Software

The main types of simulation tools most often used for modeling in IWRM are shown in Figure 2. Specialization increases as you move from programming languages to specialized water resources software. But in the process of increasing specialization, you tend to lose flexibility. Flexibility tends to be useful within the context of the interdisciplinary IWRM framework.

Figure 2. Types of simulation tools for IWRM.



Programming Languages: Programming languages, including such languages as C++, Java, Python, and Visual Basic can be used to build complex models in any field with no significant bounds of application. Many languages include useful (and extendable) libraries for building specific functionality into your models. However, while programming languages are easily accessible, well documented and standardized, it can be a significant project to build models from “the ground up.” Moreover, there are maintainability and usability concerns with models built from the ground up in programming languages, as the only person capable of effectively using the model is often the person who originally built it.

Generalized Dynamic Simulation Frameworks: Generalized dynamic simulation software, including tools such as GoldSim, can be used for business, water resources, process, and environmental modeling. This type of software is much more visually oriented than programming languages and allows the user to work at a much higher level so they can focus on the problems at hand rather than deal with specific programming constructs at the lower levels. This type of software usually comes installed with a pre-configured library of objects for carrying out standard operations (e.g., basic integration, if-then logic, reading a large dataset). These objects provide a framework for building a model very efficiently. One of the most important attributes of these frameworks is that they implicitly understand the concept of time, and hence can readily model time-varying behavior of the system. This is important, as water resources problems are almost always dynamic in nature.

Specialized Water Resources Software: Specialized water resources software can be used to model specific problems that fall within the bounds of what the software was designed to address. For example, rather than build the logic from scratch to estimate the normal depth of flow, you could select from a choice of software packages that do that routinely. Difficulties begin when you try to model water resource systems where multiple disciplines and customized components must be represented. To some extent, these kinds of systems can be represented through custom modules that are linked to specialized water resources software using a generic programming language. However, if the customization requirements become significant, these custom modules will greatly increase the complexity of the model and result in a model that is difficult to document and maintain (USDA, 2008).

The Benefits of Using Generalized Dynamic Simulation Frameworks

Given the previous discussion, it can be demonstrated that generalized dynamic simulation frameworks provide some distinct advantages, and are the methodology of choice for supporting integrated water resource management. In particular, they have the following key characteristics:

- They implicitly understand the concept of time, and hence can readily model time-varying behavior of the system, including any feedbacks that might cause unexpected changes in other parts of the system (and are often difficult to understand and explain without a model).
- They are interactive tools that can rapidly be modified to ask “what if” questions about key assumptions and processes and respond to the questions asked by stakeholders.
- They can be used to build transparent and easy to understand models, making the models easy to document, explain, and maintain.
- They are highly flexible, facilitating an integrated modeling approach that can represent the overall water use and flow behavior of a water resources system, and capture the main aspects of this behavior, both spatially and temporally (i.e., seasonally or annually).

Because of these characteristics, generalized dynamic simulation frameworks allow you to model a large system with a reasonable degree of accuracy while using

disparate data and integrating science with decision making (Ahmad & Prashar, 2010).

As a result, engineers have relied on generalized dynamic simulation frameworks for water resources modeling since the early 1970's, and they have been successfully used for a wide variety of applications, including:

- Integrated river basin planning
- Water reuse studies
- Water supply reliability assessments
- Regional water planning
- Agricultural water accounting
- Multi-criteria decision making
- Reservoir operation strategies
- Demand management studies
- Water rights allocation models
- Water-energy models
- Watershed runoff models
- Hydropower optimization

For example, these frameworks have been successfully used to assist with stakeholder participation and presentation of results (Stave, 2003). They have proven useful for analyzing different water resources policy options and estimating their long-term implications, providing transparency, and incorporating feedback mechanisms to help facilitate decision making (Simonovic & Fahmy, 1999). They have also been successful in evaluating and comparing multiple, long-range planning scenarios and water allocation options (Lillywhite, 2008).

It is imperative that innovative modeling approaches are employed to support decision making and planning in IWRM projects. The tool needs the flexibility to accurately represent unique and complex problems without requiring the programmer to develop all the modeling constructs from scratch. Dynamic simulation frameworks provide the right combination of power and flexibility to address these needs.

GoldSim is a powerful and flexible dynamic simulation framework that is well suited to modeling IWRM projects. The remainder of this paper provides an overview of the GoldSim software, describing some of its important features, followed by project examples illustrating how the software has been successfully applied to IWRM projects.

Overview of the GoldSim Simulation Framework

GoldSim is a dynamic simulation framework for modeling complex systems in business, engineering and science. GoldSim provides a general purpose framework for supporting decision and risk analysis by simulating future performance while quantitatively representing the uncertainty and risks inherent in all complex systems.

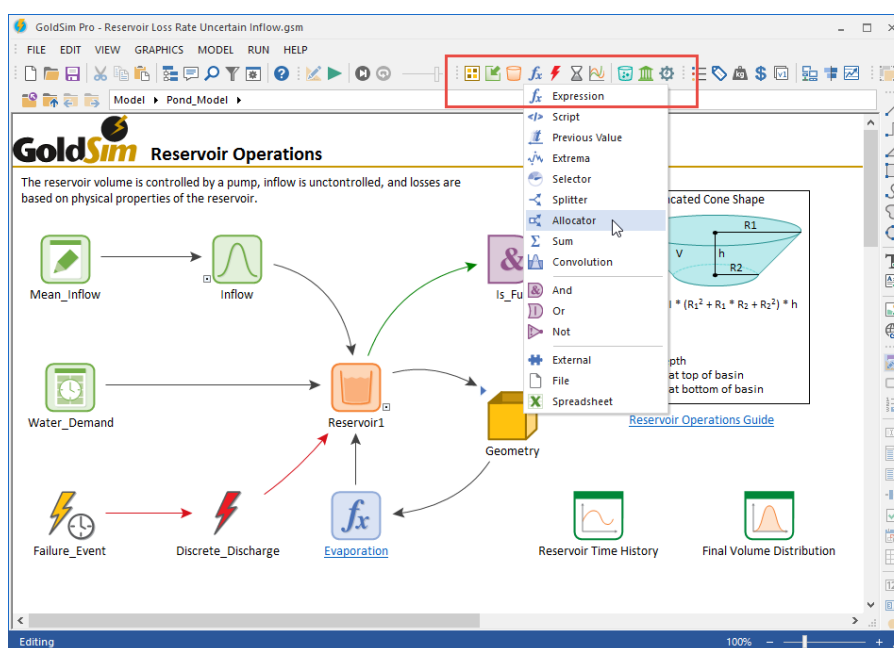
The purpose of this section is to summarize some of GoldSim's key features and illustrate how GoldSim is particularly well-suited to support IWRM.

Building Flexible Model Logic Using a Visual Interface

Since IWRM typically requires models to address a specific technical problem while also accounting for other considerations such as policy measures, economic goals, and energy use reductions, it is important that the modeling tool be flexible. Moreover, the tool needs to be easy to use, maintain and explain to others.

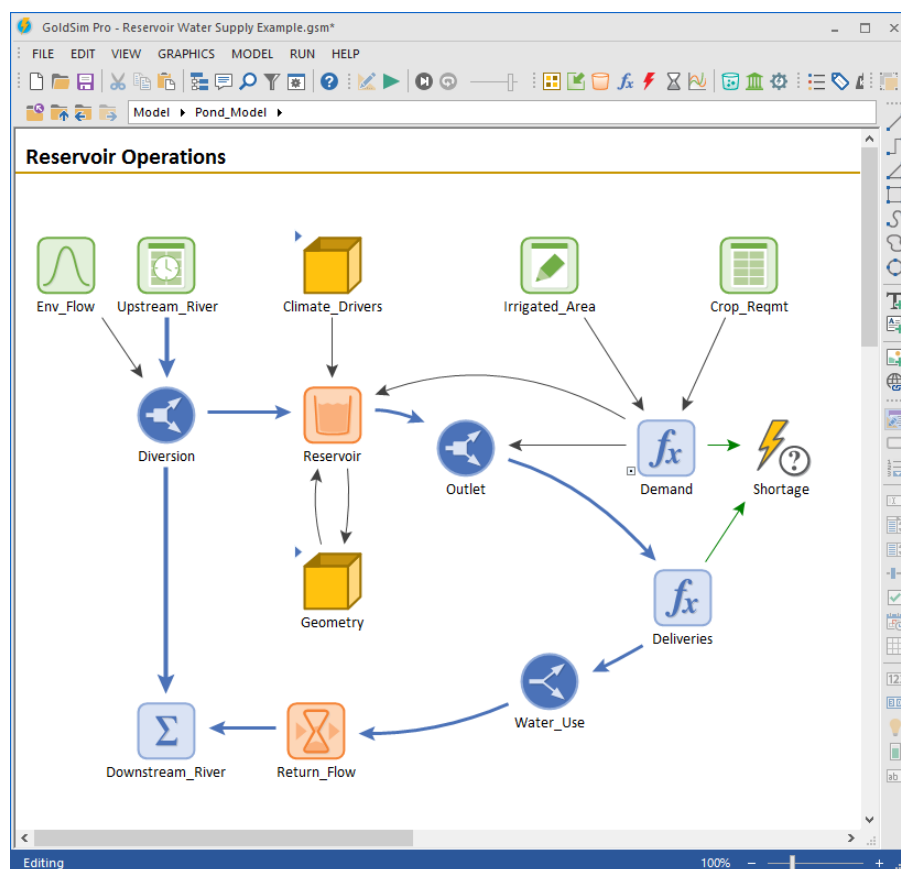
In GoldSim, models are built using graphical objects (referred to as elements) that represent properties, events, and processes within the system being modeled. GoldSim provides a library of elements that can be inserted into the model (see Figure 3).

Figure 3. GoldSim provides a variety of modeling objects that can be inserted into the model.











Based on how the various objects in your model are related, GoldSim automatically indicates their influences and interdependencies by visually connecting them in an appropriate manner (see Figure 4).

Figure 4. A simple water supply model. The objects are connected to form an influence diagram.



In a sense, GoldSim is like a "visual spreadsheet" that allows you to easily create and manipulate data and equations. Unlike spreadsheets, however, GoldSim allows the user to build a highly organizational, hierarchical model using a visual library of elements that you can drag and drop to build and change the model logic.

To better understand the kinds of elements that can be used to build a GoldSim model, it is instructive to take a closer look at the simple example of a water supply and demand model illustrated in Figure 4, and briefly discuss the elements being used in that model.

| | |
|--|--|
|  <p>Upstream_River</p> | <p>A Time Series element stores historic time series data that is referenced dynamically during the simulation. Data can be linked to MS Excel spreadsheets or external applications. This element represents the streamflow that is available for diversion to the reservoir and is based on historic stream gage records.</p> |
|  <p>Env_Flow</p> | <p>A Stochastic element represents uncertain data by sampling from a probability distribution. In this simple model, we are representing uncertain instream flow requirements to protect fish habitat.</p> |
|  <p>Diversion</p> | <p>An Allocator element is used to allocate an incoming signal into multiple outputs given specified demands and priorities. For this model, streamflow is allocated between the fish flow and the diversion requirement. Any water not diverted flows downstream.</p> |
|  <p>Crop_Reqmt</p> | <p>A Lookup Table defines a relationship between two model variables. In this case, the table represents the relationship between the irrigated area and the irrigation demand.</p> |
|  <p>Demand</p> | <p>An Expression element allows you to define mathematical or logical expressions involving state and model variables. In this case, we calculate the changing irrigation demands and apply them to the reservoir.</p> |
|  <p>Reservoir</p> | <p>A Reservoir element is a critical element in all water resource models. It integrates inflows and outflows of materials, allowing for upper and lower bounds to be specified.</p> |
|  <p>Climate_Drivers</p> | <p>A Container element is used to encapsulate model logic in a hierarchical manner in order to preserve the organization of the model so that it remains easy to understand. This particular container is used to calculate the evaporation, precipitation, and seepage flows that affect the reservoir volume with feedback to/from the reservoir.</p> |
|  <p>Shortage</p> | <p>A Triggered Event element is triggered whenever a supply shortage occurs and is used to accumulate and report this important statistic.</p> |

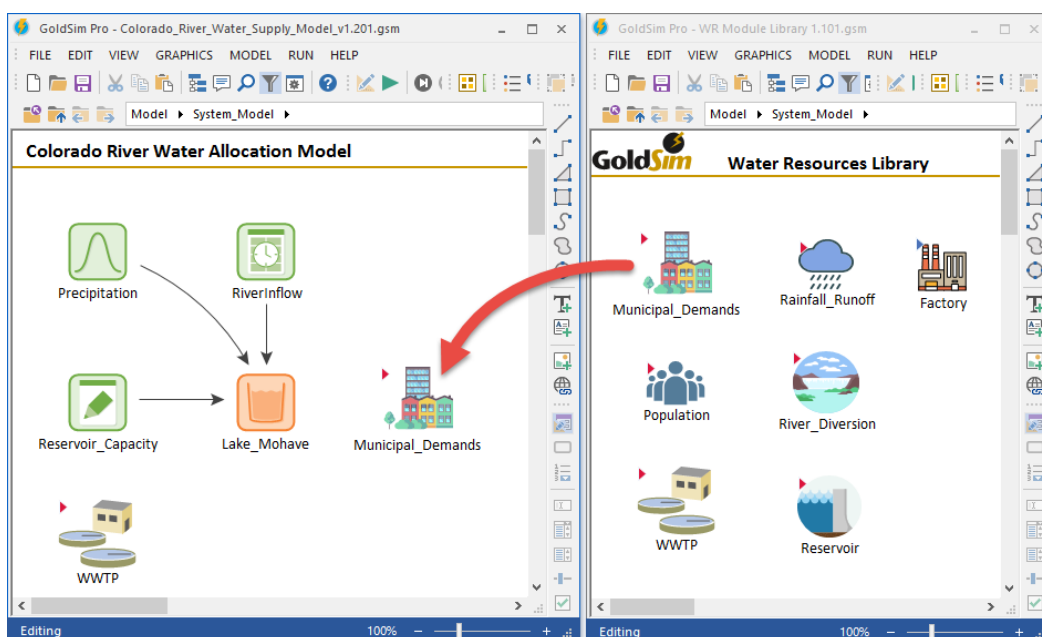
Although this model is simple, it is illustrative of the way GoldSim models are built and how they provide a graphical representation of the system.

Building Hierarchical and Modular Models

GoldSim models can be built in a hierarchical and modular manner, by creating and linking together subsystems (submodels). The submodels can include custom (legacy) codes that can be linked dynamically into GoldSim. These submodels, after being built for one application or project, are often readily transferable with only minor modifications to another application. Hence, one of the key benefits of a hierarchical and a modular structure is an efficient use of reusable model logic across multiple modeling applications and sharing the models across an organization.

Figure 5 is a screen capture showing how a shared library can be used to assist with the development of new models without redesigning components every time they are reused.

Figure 5. Reusing a pre-programmed module from a custom library.

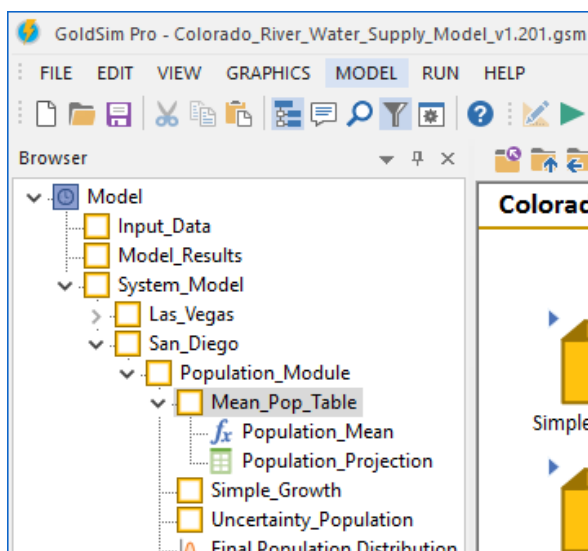


The GoldSim framework is designed to allow components of models to be saved (and perhaps posted to an internal website), and then re-used in other models for other projects within the organization. Sharing and re-using these components in this manner can result in significant cost savings by eliminating the need to “reinvent the wheel.” In effect, GoldSim acts as a framework to share knowledge and experience across the organization. Not only does this reduce redundant efforts, it promotes consistency in the assumptions and approach to environmental modeling within the organization.

In addition to facilitating model reuse, the ability to build an organized hierarchical model is important because it provides a simple way to navigate the model that is similar to the way the logic and data of the real system is often organized. This makes it easier to explain, maintain and modify your models. Figure 6 shows how a typical

model might be organized. The tree navigation window of the software allows you to visualize the hierarchy of the model components.

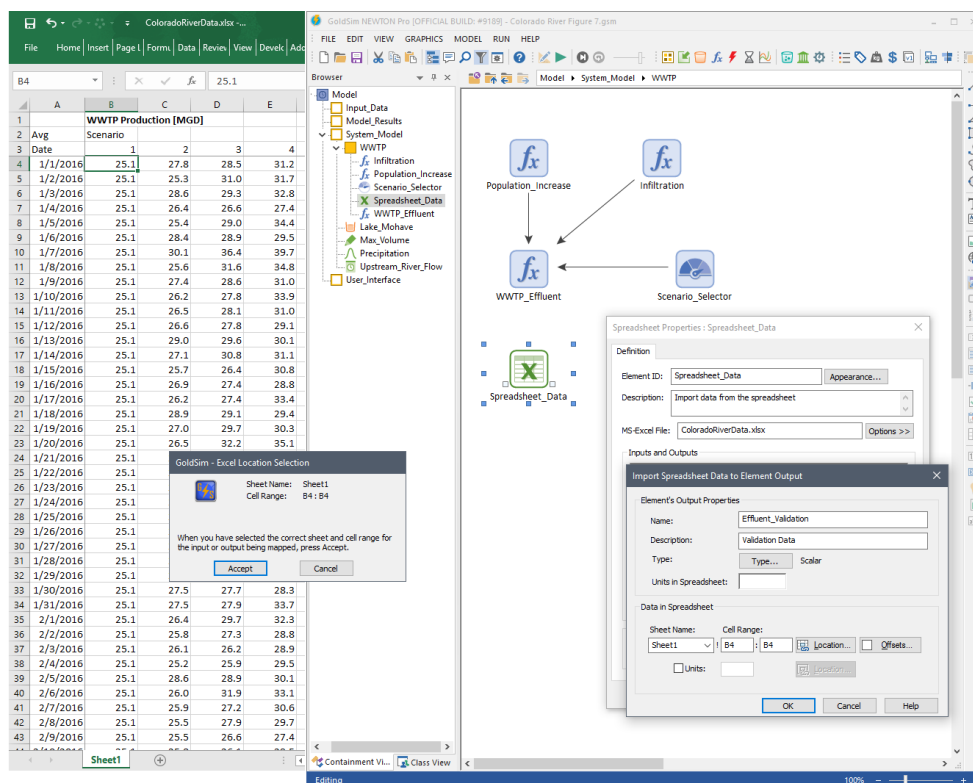
Figure 6. Navigation tree showing model hierarchy.



Connecting Your Model to Databases and Spreadsheets

Within IWRM projects, it is quite common to import large quantities of data (e.g., rainfall, flowrates) from a spreadsheet or database. Moreover, IWRM projects often may require robust post processing within a spreadsheet. GoldSim is very flexible in allowing the user to interface with data that is stored in databases and spreadsheets. GoldSim can both import data from and export data to databases and spreadsheets. As shown in Figure 7, GoldSim provides a simple user-friendly interface to directly interact with these data repositories.

Figure 7. Connecting a GoldSim model to a spreadsheet.



Creating Compelling Presentations

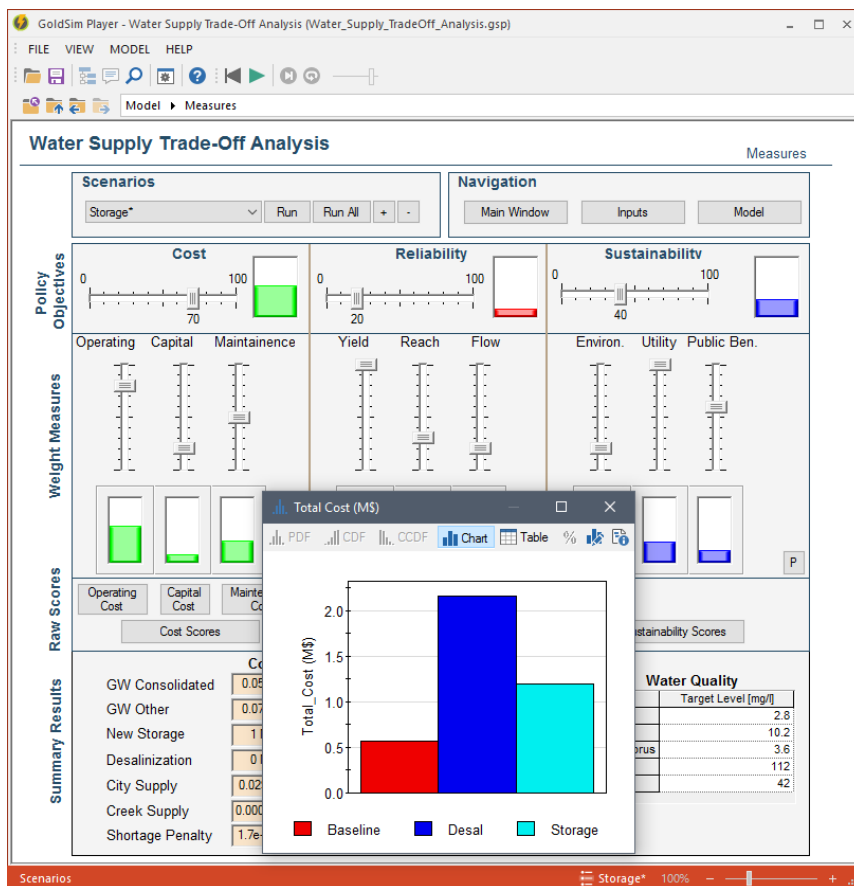
GoldSim allows you to create compelling presentations of your model, facilitating effective interaction with stakeholders. A model that cannot be easily explained is a model that will not be used or believed. GoldSim was specifically designed to allow you to effectively document, explain and present your model. You can add graphics, explanatory text, notes and hyperlinks to your model, and organize it in a hierarchical manner such that it can be presented at an appropriate level of detail to multiple target audiences.

The ability to create hierarchical, top-down models, coupled with GoldSim's powerful documentation features, allows you to design transparent, highly-graphical models that can be effectively explained to any audience at an appropriate level of detail. Moreover, GoldSim facilitates real-time model experimentation (e.g., the ability to answer stakeholder "What If?" questions during a meeting). Transparent, easy to understand models and real-time model experimentation promote effective interaction with regulators and other stakeholders, and help to build trust. This ultimately can help you avoid costly delays and requests for additional (and technically unnecessary) modeling studies or data collection.

In addition, GoldSim provides a specialized set of tools that allow you to create custom interfaces, or "dashboards" for your models to make them accessible to non-technical users. Models created using the GoldSim Authoring tools can be saved and subsequently viewed and run using the free GoldSim Player. The interfaces can be designed to include buttons, input fields, sliders and result displays, and the author

can embed text, tool-tips and graphics to provide instructions on the use of the model. Such an interface allows a model to be easily used by someone without requiring them to be familiar with either the GoldSim modeling environment or the details of the specific model. In effect, this allows you to use GoldSim as a high-level programming language to create custom simulation applications for distribution to end users who may not necessarily be modelers. Figure 8 shows a typical “dashboard” that can be created using GoldSim.

Figure 8. GoldSim dashboard example.

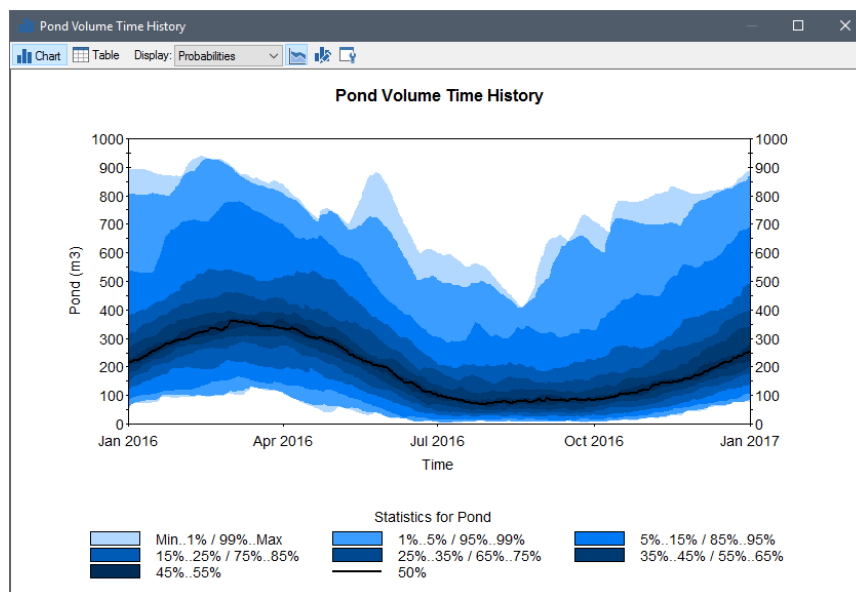


Representing Uncertain and Stochastic Processes Using Monte Carlo Simulation

GoldSim was designed from the outset to represent uncertain and stochastic processes and events. This is done by specifying model inputs as probability distributions. This capability makes it relatively easy to represent uncertain variables, as well as generate stochastic records of precipitation, evaporation and other system drivers such as demand. The impact of uncertain events (e.g., earthquakes, floods, sabotage) can also be directly represented by specifying the occurrence rates and consequences of such "disruptive events". GoldSim uses Monte Carlo simulation to propagate uncertainty through the model.

GoldSim also provides rich result displays to help the audience understand what the modeler is trying to portray. For example, Figure 9 shows a probabilistic time history plot of snow coverage over a one-year period.

Figure 9. Probability time history of snow coverage.



Extending GoldSim Using Customized Objects, Modules and Programs

GoldSim provides a wide variety of built-in objects (“elements”) from which you can construct your models, and, if desired, you can program your own custom objects, and link them seamlessly into the GoldSim framework. Custom objects can be programmed within GoldSim (using built-in scripting features). You can also dynamically link your own custom external programs or spreadsheets directly into your GoldSim model. In addition, GoldSim was specifically designed to support the addition of customized modules (program extensions) to address specialized applications (e.g., contaminant transport modeling, reliability and failure modeling).

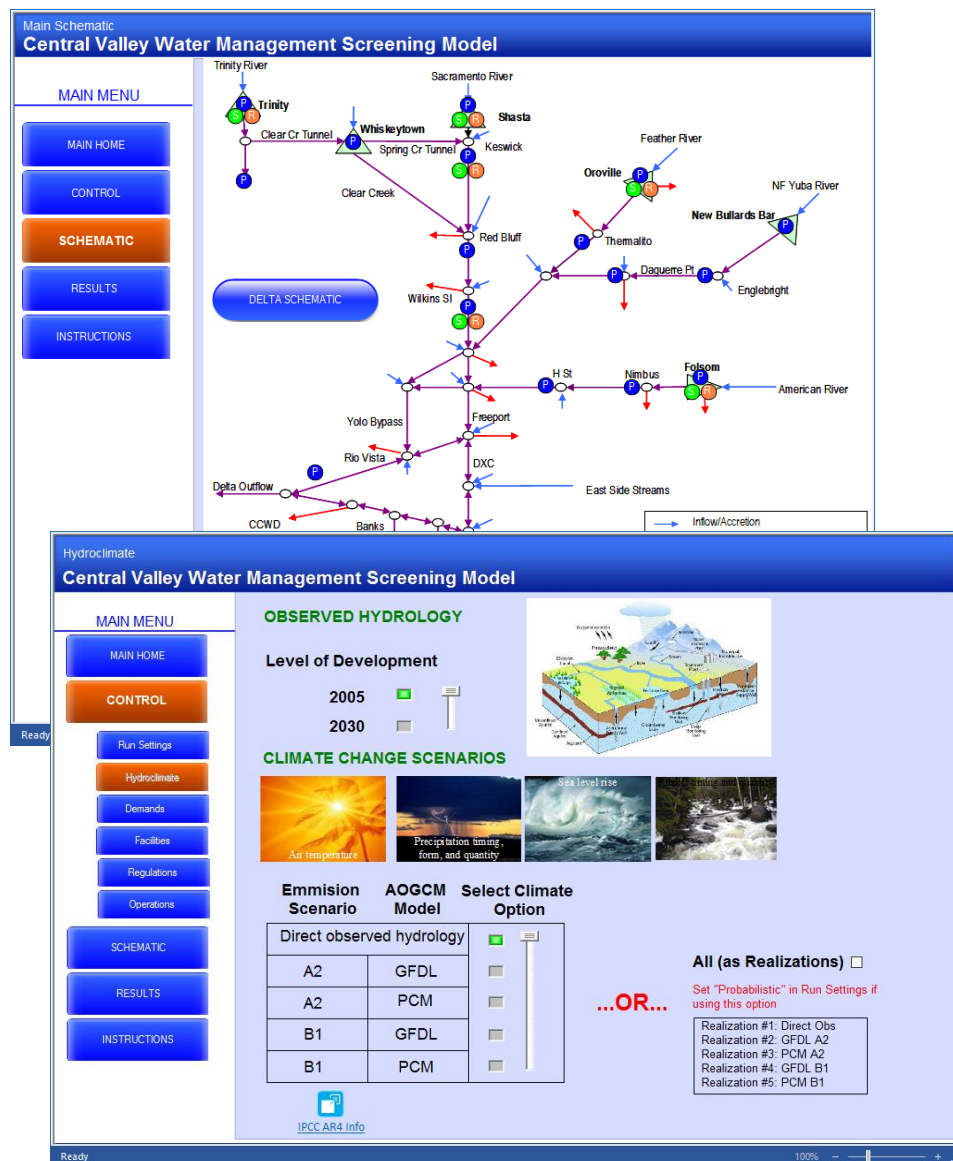
Example GoldSim Water Resource Applications

This section presents short descriptions of several models built using GoldSim in order to illustrate its application to integrated water resource management.

CalLite: Central Valley Water Management Screening Model

The Department of Water Resources, CA (DWR) and US Bureau of Reclamation mid-Pacific region (USBR), worked with CH2M HILL to develop a GoldSim screening model to assist decision makers and water resources engineers in the planning and management process for the State Water Project and Central Valley Project in California. This screening model, named CalLite, simulates the hydrology of the Central Valley, reservoir operations, project operations and delivery allocation decisions, delta salinity responses to river flow and export changes, and habitat-ecosystem flow indices (see Figure 10).

Figure 10. CalLite model dashboards.



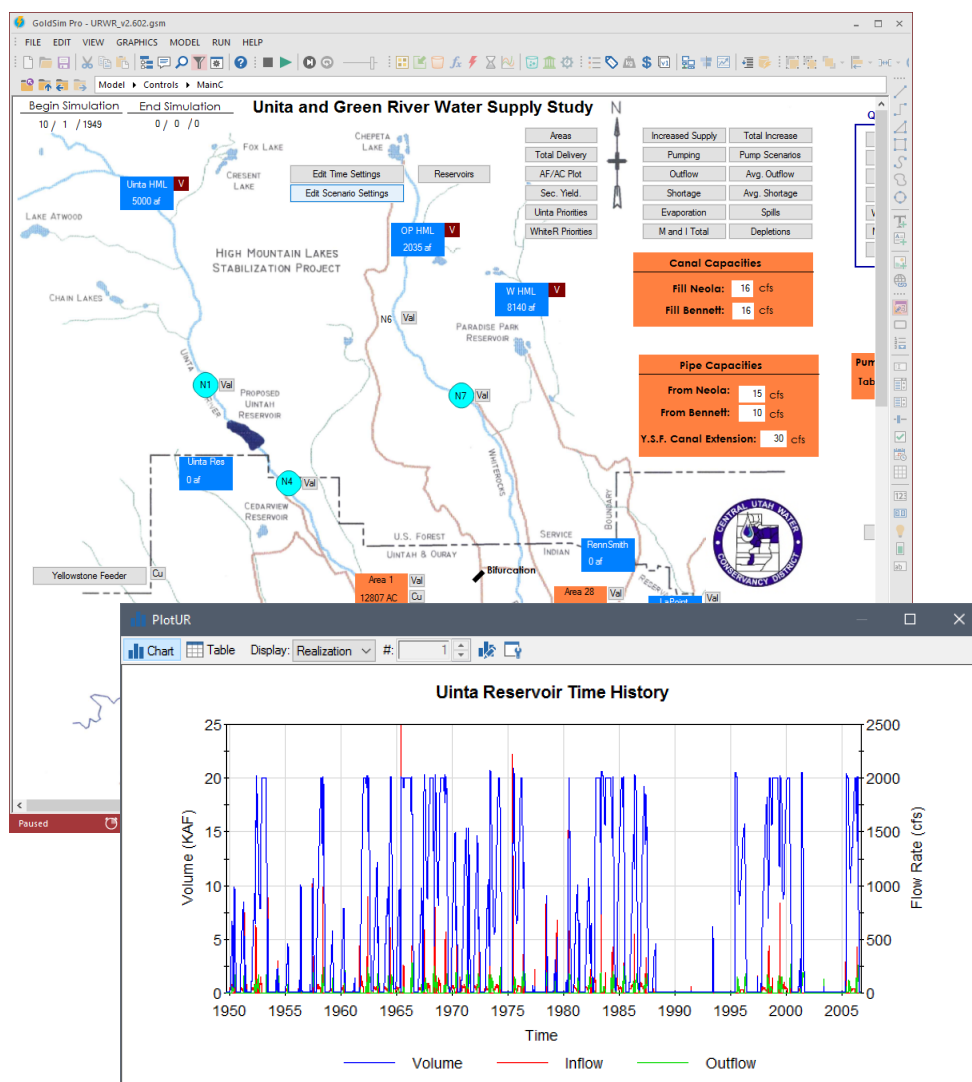
CalLite simulates water conditions in the Central Valley, California over an 82-yr planning period (water years 1922-2003) and allows interactive modification of a variety of water management actions including alternative conveyance options, storage options, and river and Delta channel flow and salinity targets. The screening tool is designed for use in a variety of stakeholder processes for improved understanding of water system operations and potential future management changes (Islam, 2010). The tool bridges the gap between more detailed system models (CalSim) managed by DWR and USBR, and policy/stakeholder demand for rapid and interactive policy evaluations. CalLite can be applied to assist in the screening of a variety of water management options and to educate decision makers on system responses.

The CalLite model is easy to use and reduces run time (as compared to CalSim) significantly. The simulation results obtained from a typical CalLite run are within 5% of a corresponding CalSim run while run time is less than 5 minutes compared to 30 minutes for a corresponding CalSim run. The decrease in runtime provides for more opportunity to interact with the model and provide more efficient insight and feedback for the decision-making process.

Uinta and Green Rivers Water Development Projects

The purpose of this project was to justify the growing need for new water supply projects in the Uinta Basin of Eastern Utah. Currently, water users in the basin are experiencing water shortages and water managers foresee significant municipal growth in cities and towns, new irrigated lands for agriculture, and a booming energy demand growth. A GoldSim model was developed for this project to determine the validity of new supplies, including trans-basin import water, on and off stream storage, and water right exchanges (see Figure 11).

Figure 11. Uinta River Water Supply Model.



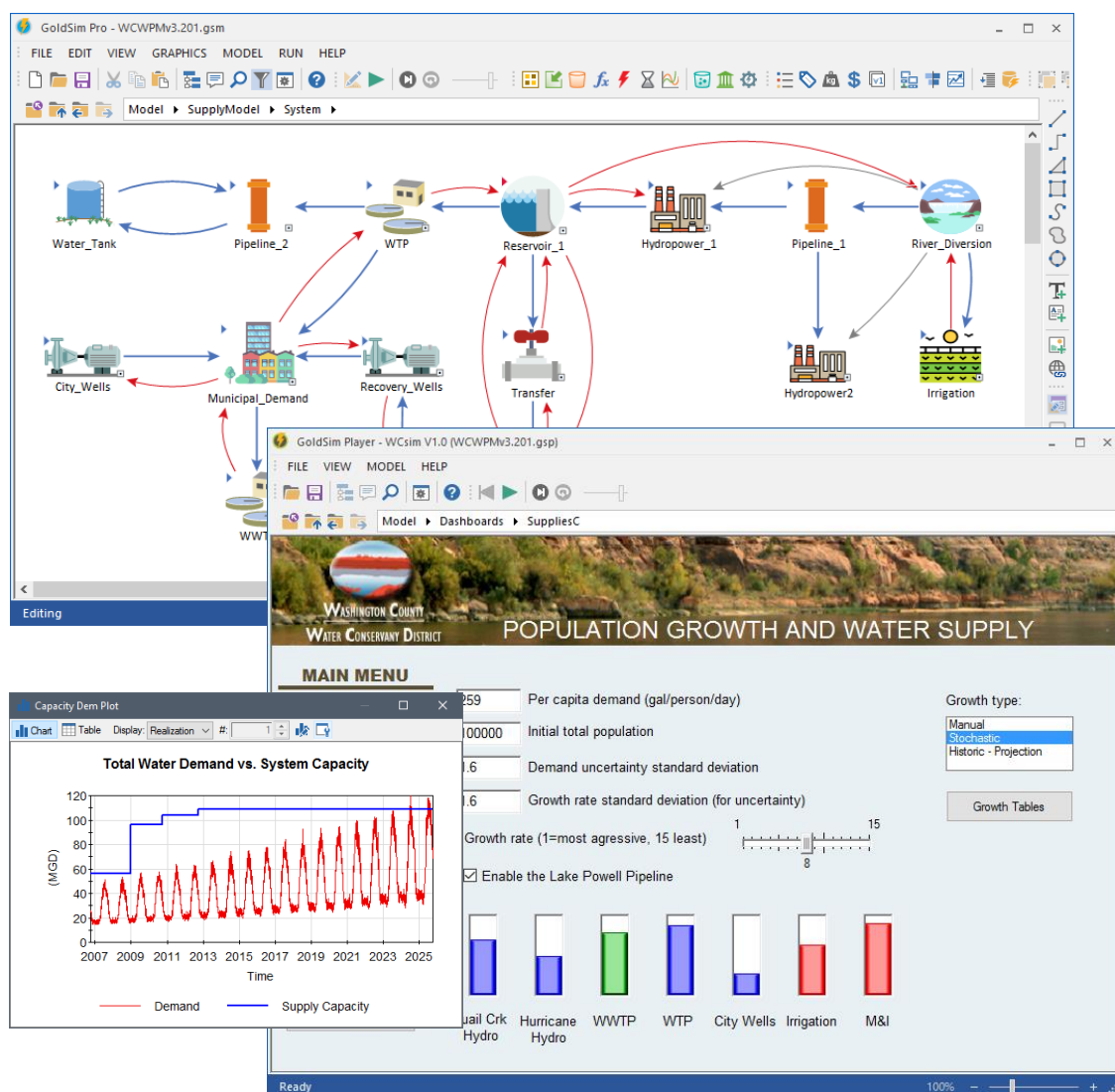
The model simulates existing water demands and the supplies available based on a 90-yr period of record. Once the model was calibrated and validated by comparison to an older legacy model, future water supply needs were evaluated in the model. The water allocation throughout this basin is coordinated through a complex water rights prioritization process. The graphical and modular aspects of GoldSim made it possible to construct a model that was simple to understand yet captured the complex water allocation process.

A group of stakeholders, engineers, and decision-makers were tasked with choosing a water supply option from twelve alternatives (CH2M HILL, Franson Civil Engineers, 2007). The model was used to assist with the decision making process during stakeholder meetings. During these meetings, participants deliberated over the costs and benefits of each of the twelve project alternatives and narrowed the decision down to three options using the results of the GoldSim model. Changes were made to the model on the fly followed by viewing of revised results immediately. The GoldSim software was able accommodate this need efficiently.

Water Supply Reliability and Marginal Cost Model

The purpose of this study was to develop and apply a unique concept of combining marginal cost and reliability in an operational water supply model (see Figure 12). This study was used to gauge the performance of various water supply strategies by assessing the reliability of water supply and marginal costs, incorporating both supply and demand-side management options. Risk-based reliability of the system was estimated as a function of shortages in flow rate and system storage volumes. The new approach was applied to a water supply planning model for the Washington County Water Conservancy District, a regional water wholesaler located in St. George, Utah.

Figure 12. Water supply reliability model.



The results of this study showed that increased operational efficiencies could be found while maintaining higher reliability in the system. The results also showed that this approach could provide better insight into timing of large future supply acquisitions (Lillywhite, 2008). The GoldSim model was built with four main system modules including a supply-demand module, a shortage management action module, a reliability forecast module, and a system performance module. The reliability forecast module used GoldSim's Monte Carlo feature to efficiently quantify system performance for the planning period.

Snowmelt Runoff and Reservoir Operations Study

The objective of this study was to use the snowmelt runoff methodology from the USDA Snowmelt-Runoff Model (WinSRM) to develop a probabilistic approach to

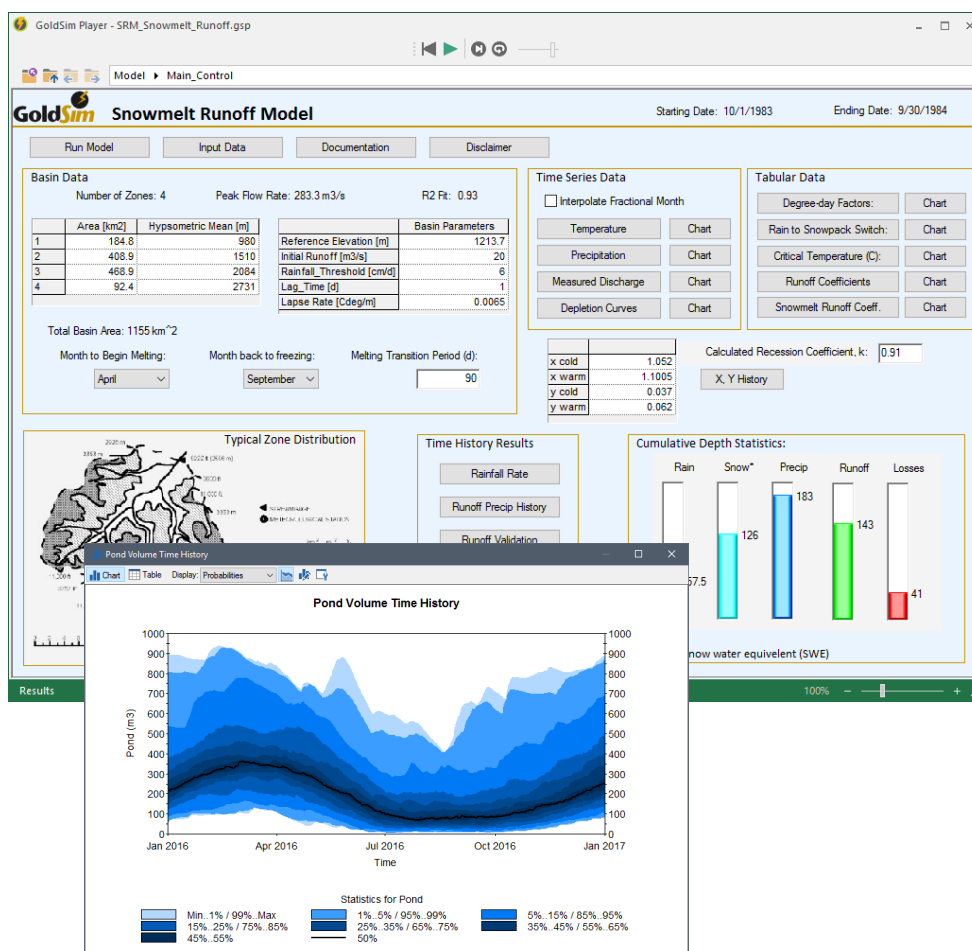
determine the risk of spill and supply shortage at a hypothetical reservoir that collects water from the upper Weber River basin.

The WinSRM is designed to simulate and forecast daily streamflow in mountain basins where snowmelt is a major runoff factor (Martinec, 1975). Most recently, it has also been applied to evaluate the effect of climate change. A simple snowmelt model was developed using GoldSim and the results of the algorithms were tested and validated against that of a similar model created in WinSRM.

A hypothetical reservoir was added to the model so that any changes made to the runoff parameters automatically affect the operation of the reservoir. The tool takes into account temperature and precipitation, so the model can be used to evaluate the impact of these parameters on reservoir operations.

This implementation provides a tool that can be used for risk analysis of operations of existing reservoirs located in snowmelt dominated watersheds. By integrating the snowmelt runoff algorithm into GoldSim, it became possible to leverage GoldSim's key features in these models, such as adding integrated system modules, running probabilistic simulations, developing a user interface, and providing user-friendly results (see Figure 13).

Figure 13. GoldSim snowmelt model.



Summary

Water resources are vital to our world, and it is becoming more important that we efficiently manage this resource as demands continue to diversify and increase. Integrated water resources management (IWRM) can be an effective framework to assist with the planning and decision-making of a wide range of water resources systems. A dynamic system modeling tool is very effective in helping stakeholders, engineers, and decision-makers visualize the system components, how they interact, and the effects of their proposed decisions.

GoldSim is a powerful and flexible Windows-based computer program for carrying out probabilistic simulations of complex systems to support management and decision-making in engineering, science and business. The program is highly graphical, highly extensible, able to directly represent uncertainty, and allows you to create compelling presentations of your model.

GoldSim is particularly well-suited to integrated water resources management applications. In particular, it allows you to create realistic models of water resources systems in order to carry out risk analyses, evaluate potential environmental impacts, support strategic planning, and make better management decisions. GoldSim has been successfully used for applications such as:

- Integrated river basin planning
- Water reuse studies
- Water supply reliability assessments
- Regional water planning
- Agricultural water accounting
- Multi-criteria decision making
- Reservoir operation strategies
- Demand management studies
- Water rights allocation models
- Water-energy models
- Watershed runoff models
- Hydropower optimization

The software has been used by customers around the world for water and waste management studies, to support environmental compliance and permitting, for watershed planning studies, and water supply and demand forecasting.

About the GoldSim Technology Group

The GoldSim Technology Group is a privately held software company dedicated to delivering software and services to help people understand complex systems and make better decisions. The combination of our diverse technical and business backgrounds, our extensive experience in modeling complex systems, and our ability to continuously enhance our state-of-the-art simulation tools allow us to efficiently solve difficult problems that cannot be readily addressed by others.

Our flagship GoldSim software package is based on technology developed over a period of nearly 20 years. GoldSim has been used by and/or for a diverse set of customers and clients, including government agencies in over 10 countries, and commercial organizations worldwide, including engineering firms such as Golder Associates, CDM, CH2M Hill, MWH, URS, and Bechtel; water organizations like Central Arizona District and San Francisco Public Utilities, and mining companies such as Anglo American, Newmont Mining Corporation, and Rio Tinto.

The GoldSim Technology Group focuses on building great simulation software and supporting the technical aspects of building effective GoldSim models. To provide other dimensions of complete solutions, we maintain close relationships with partners around the world, including consulting firms with specific expertise in civil engineering, water resources and mining.

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