

RECLAMATION

Managing Water in the West

Groundwater Model Coupling to Reclamation Surface Water Models – Scoping Report

Research and Development Office
Science and Technology Program
Final Report ST-2015-0806-1



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Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Executive Summary

Groundwater Model Coupling to Reclamation Surface Water Models Scoping Proposal Z0806 Report of Findings

Prepared by: Sean Kimbrel, D. Nathan Bradley

Introduction

Reclamation currently has a suite of surface water numerical models. Reclamation's one-dimensional numerical hydraulics and sediment transport model, SRH-1D, and two-dimensional numerical hydraulics and sediment transport model, SRH-2D, both have extensive capabilities in predicting surface water properties and interactions in rivers, reservoirs, canals, and other hydraulic features. These surface water numerical models, however, do not address the important groundwater and surface water interactions.

This scoping research study addresses the following question:

How can we improve Reclamation's capability in numerically modeling the interaction between groundwater and surface water resources for various Mission related needs and goals?

The research product from this research scoping study is a new conducting research proposal describing the plan and budget to link the SRH models to a groundwater model, which is outlined in the following section.

Research Outcome and Proposal of Future Work

In order to begin the process of answering the aforementioned research question, in FY 2015, Reclamation staff coordinated with other federal agencies, including the United States Geological Survey (USGS), to research ways to couple SRH-1D and SRH-2D with a groundwater model, with the goal of finding the most appropriate groundwater model to couple to the SRH models.

Coordination with USGS staff and a review of the existing literature led to decision to couple Reclamation's hydraulic model, SRH-2D (Lai, 2008), to GSFLOW (Markstrom et al., 2008). GSFLOW is an open-source software package developed by the USGS that couples models of surface and near-surface processes to MODFLOW, a commonly used groundwater model. The GSFLOW package integrates the USGS Precipitation-Runoff Modeling System (PRMS) and the USGS Modular Groundwater Flow Model (MODFLOW). The PRMS model intent is to simulate the hydrologic cycle at the watershed scale. The intent of coupling the SRH-2D model to GSFLOW is for simulating surface-water and groundwater processes at scales smaller than the watershed scale (e.g. reach scale).

Reclamation's hydraulic models will replace the Streamflow Routing Module (SFR2) in GSFLOW. SFR2 is a simplified surface water flow routing scheme that lacks the detailed predictive ability of SRH-2D. The coupling will follow the example of Tian et al. (2015) who replaced SFR2 with the Storm Water Management Model (SWMM), a surface water flow model that is similar in some respects to Reclamation's hydraulic model.

Based on the decision and goal to couple SRH-2D to GSFLOW, the following tasks are outlined in the conducting research proposal submitted on July 1, 2015 to the S&T Research Office:

Task 1. Development of Model Coupling. Reclamation staff will develop software that interacts with the intact GSFLOW modules by taking advantage of the algorithms and application programming interfaces (APIs) used by SFR2. This approach will minimize the number of changes to either the SRH-2D or GSFLOW code bases. The principal challenges in integrating the two models are reconciling the disparate time step sizes (seconds for a hydraulic model, a day or more for GSFLOW) and exchanging data between the models.

Task 2. Testing and Debugging. This task is set aside to test and debug the coupled model on a simplified case, in order to validate the model coupling development.

Task 3. Field Data Verification. Field locations where GSFLOW or MODFLOW models are already developed will be used for field data verification.

Potential sites where groundwater models are already developed include a field site at the Sagehen Creek Field Station in California (used for GSFLOW validation), the San Joaquin River in the Central Valley of California, and South Park in Colorado.

Additional topography and bathymetry for input to SRH-2D may need to be collected at a selected field site for model verification.

Task 4. Reporting and Peer Review. This task sets aside funding for the reporting the development and application of the Module to link SRH-2D and MODFLOW. Funding is also set aside for peer review to be performed by Reclamation and USGS staff.

Future Research Products

The research product of this study will be a formatted report and/or journal article describing the development and use of the Groundwater Surface Water Model coupling module.

References

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