FIU | Applied Research Center
FLORIDA INTERNATIONAL UNIVERSITY

U.S. DEPARTMENT OF ENERGY

ENVIRONMENTAL REMEDIATION SCIENCE & TECHNOLOGY

PROJECT: Environmental Remediation Science & Technology: *Hydrology and Contaminant Fate and Transport Modeling at DOE Sites*

LOCATIONS: Savannah River Site (SRS), Aiken, SC and Nash Draw Basin 6 near the WIPP, Carlsbad, NM
PRINCIPAL INVESTIGATOR: Dr. Leonel Lagos
TASK MANAGERS: Dr. Pieter Hazenberg (Senior Research Scientist) and Angelique Lawrence (Research Specialist II)

Description:

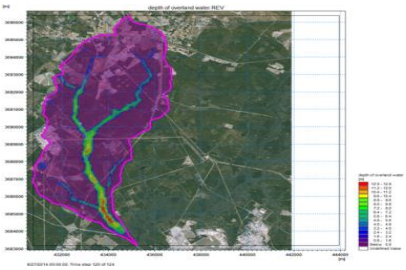
FIU-ARC is developing numerical models to study the impact of climate change on hydrology and the fate and transport of priority contaminants at DOE sites. The knowledge gained through these studies will provide a means of assessment, evaluation and post-closure long-term monitoring of water quality and environmental conditions following remedial activities. The models provide information needed for informed decision-making in existing DOE-EM soil and groundwater remediation programs. Results obtained will provide DOE-EM suggestion of key locations for contaminant monitoring. Furthermore, the models can be utilized as forecasting tools to predict suspended sediment loads and the extent of remobilization regimes under different scenarios of extreme storm events and erosion conditions.

Contaminant Fate and Transport Modeling for the Savannah River Site (SRS)

1. *The Tims Branch Watershed Model*

A contaminant transport model has been developed to simulate the impact of extreme storm events on the hydrological response and the transport of uranium in the Tims Branch watershed. Tims Branch was used as a test bed to develop a modeling approach for examining the response of a braided stream system at SRS to historical and future discharge events, simulation of heavy metal transport, and assessment of environmental management remediation actions, that can be subsequently extended to other more critically contaminated stream systems at SRS.

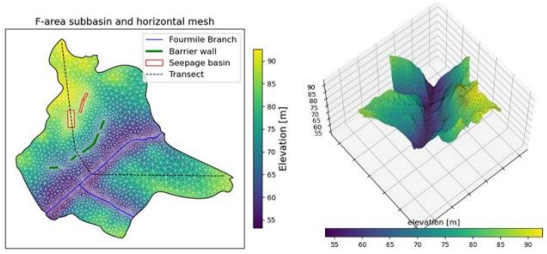
The model simulates surface water flow (velocity, depth, and discharge), sediment and uranium fluxes throughout Tims Branch during extreme precipitation events ranging from 5-year to 500-year return periods, with storm durations ranging from 6-hour to 96-hour.



MIKE SHE simulation of seasonal overland flow

2. *Model Development for Fourmile Branch with Specific Focus on the F-Area Wetlands*

FIU-ARC has generated a model-builder to enable fast implementation of the abovementioned modeling approach to other more critically contaminated SRS basins and has applied it to develop a model of the Fourmile Branch watershed to understand the flow and sediment transport variability across Fourmile Branch watershed and how this impacts the migration of F-Area contaminants downstream.



2D & 3D views of the F-Area hillslope

In addition, a high-resolution hydrology model of the SRS F-Area was developed using the Advanced Terrestrial Simulator (ATS) and the Python package Watershed Workflow. This model will improve our understanding of the interaction between the groundwater flow downslope of F-Area with the seepage face and riparian zone adjacent to the braided river network, making use of model and in-situ observations.

ABOUT

Since 1995, the Applied Research Center at Florida International University has provided critical support to the Department of Energy's Office of Environmental Management mission of accelerated risk reduction and cleanup of the environmental legacy of the nation's nuclear weapons program. ARC's research performed under the DOE-FIU Cooperative Agreement (Contract # DE-EM0005213) can be classified as fundamental/basic, proof of principle, prototyping, and laboratory experimentation.

Project Contact:
Dr. Pieter Hazenberg
Ph: (305) 348-8218
Email: phazenbe@fiu.edu
10555 W. Flagler Street, EC 2100 Miami, FL 33174
arc.fiu.edu

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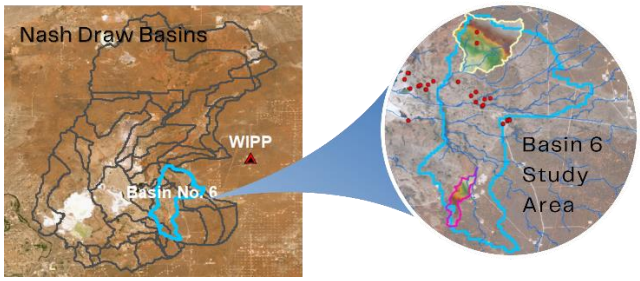
Hydrology Modeling of Basin 6 of the Nash Draw West of the Waste Isolation Pilot Plant (WIPP)



A hydrological model of Basin 6 of the Nash Draw west of the WIPP site has been developed using the Advanced Terrestrial Simulator (ATS).

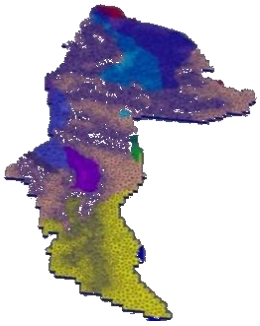
A greater understanding of the regional water balance is needed, particularly the relationship between the Culebra recharge and the intense, episodic precipitation events typical of the North American monsoon.

Significance & Benefits

- Regional multi-scale land-atmosphere modeling capability.
- Assessment of long-term repository performance via estimation of groundwater recharge, halite dissolution and propagation rate of shallow dissolution front.

As recharge is anticipated to predominantly occur at localized features, such as along the river network, gullies and within sinkholes and swallets, the ATS model for Basin 6 was developed based on a 1-meter DEM. This high-resolution model will enable computation of the water balance across multiple scales, simulation of the groundwater recharge and estimation of the propagation rate of the shallow dissolution front.

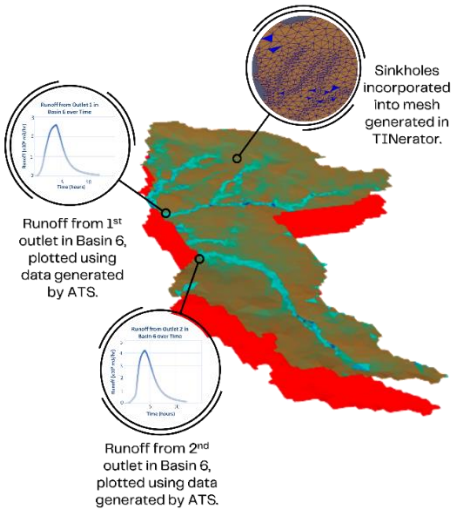
Furthermore, long-term changes in climate are expected to result in more frequent intense precipitation events, but it is currently unknown if this will lead to increased groundwater recharge.



ATS mesh of Basin 6. Colors indicate different land surface classes.

The Python package, Watershed Workflow, was used to enable quick generation of an ATS model from publicly available data. The developed workflow was successfully implemented and ATS was able to perform simulations on FIU's high performance computer (HPC). The model will be calibrated using observations to be collected during summer of 2023.

Once fully developed, the model will be used to evaluate the impact of seasonal and decadal variations in weather (including climate change) on the regional hydrology and groundwater recharge, so DOE-EM scientists can better predict the rate of halite dissolution and propagation of the shallow dissolution front in order to quantify the potential impact on the WIPP repository performance.



Path Forward

Improve Basin 6 model by adding more data elements → Expand simulations to entire Nash Draw area → Perform sensitivity & uncertainty analyses