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# The Knowledge Stream

## Research Update

# Modeling How Large Woody Debris Structures Affect Rivers

*Modeling river changes from large wood structures and other instream structures*

## Bottom Line

**This research project analyzed a number of existing state-of-the-art modeling tools for their suitability to predict the flow and morphological changes caused by large wood and instream structures so that the tools may contribute to the design.**

## Better, Faster, Cheaper

**While several Reclamation regions have used large wood structures for river restoration, their use has been challenged due to a lack of general design guidelines that address the risk, safety, and morphological impacts. Providing a numerical model that can predict these impacts will allow Reclamation to use this river restoration technique responsibly and effectively. Moreover, these modeling tools, once verified, could also be used for a wide range of Reclamation projects (e.g., design guidelines for instream structures and fish habitat studies).**

## Principal Investigator

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## Problem

Providing large wood features in a stream can help restore rivers and recover endangered species by re-establishing flow patterns and enhancing habitat. However, these large woody structures may cause scour and change the shape of the river—and these processes and risks are not well studied or understood.

Methods and guidelines for determining risk, designing structures that effectively provide habitat and restore rivers, and predicting the river's response to large wood structures are not available. Traditional methods to measure and predict scour mostly rely on data from flumes, which suffers from scale problems. Field data for scour are scarce and expensive to obtain.

Moreover, large wood structures' irregular forms make laboratory or field studies difficult. Large wood in rivers is usually in a chaotic form, with logs, branches, roots, and slash materials in various sizes and at different angles—forming an array of interwoven geometries. This collection of geometries presents a challenge when trying to replicate as a three-dimensional (3D) solid model.

However, accurate scour and morphological predictions for these complex forms are becoming feasible as more numerical modeling tools become available. These

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*Logjam on the lower Trinity River. Photograph courtesy of the Trinity River Restoration Program.*

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tools need to be evaluated and tested for large woody structures to determine their risk, safety, and scour and morphological impacts.

Computational fluid dynamics (CFD) modelling is an attractive alternative. However, CFD modelling for large wood structures has its own challenges—the difficulty of mesh representation and lack of reliable and practical 3D flow and mobile-bed models.

## Solution

This Reclamation Science and Technology Program research project evaluated models and potential field work to determine what could be used to understand the flow field around large wood structures and the morphological changes that these structures may cause.

Test cases on the Trinity River were selected and constructed wood jams were studied by collecting high resolution terrestrial and bathymetric topography to establish a monitoring baseline.

*Engineered logjam on the Trinity River under floodflows. Photograph courtesy of the Trinity River Restoration Program.*

## Future Plans

This study determines that some models could become the primary quantitative prediction tools for scour and morphological impacts related to large wood structures. Collecting repeat data after high flow releases to capture any morphological changes over time is proposed. In addition, unique tools will be deployed to capture the underwater vertical face of the constructed wood jams. These data collections will pose the most challenges due to the logistics of dealing with swift current and limitations with marine equipment applied to a complex riverine environment. These data will be used to evaluate and compare against the predicted results of the 3D hydraulic modelling output. A number of collaborators could help to evaluate models, including:

- U2RANS: A 3D numerical model developed at the University of Iowa and modified and improved for realistic riverflows at Reclamation
- SRH-2D: A 2D hydraulic and sediment transport model developed by, and widely used at, Reclamation and by external universities, research institutions, and consulting companies
- OpenFOAM: An open source CFD model

***"State-of-the-art computational fluid dynamics modelling could help us understand how large wood structures work and interact in a river environment."***

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## Collaborators

- **Reclamation's Trinity River Restoration Program**
- **Penn State University**
- **U.S. Army Corps of Engineers**
- **Taiwan Water Resources Agency**

## More Information

**www.usbr.gov/research/projects/detail.cfm?id=5772**