

# **Report for 2001IL4321B: Integrated Engineering and Geomorphological Analysis for Assessing the Performance of Bendway Weirs in Southern Illinois**

There are no reported publications resulting from this project.

Report Follows:

**Illinois Water Resources Center**  
Annual Report Format  
Spring 2002

**1. Project Number:**

**2. Project Title and PIs:** Integrated Engineering and Geomorphological Analysis for Assessing the Performance of Bendway Weirs in Southern Illinois, Bruce Rhoads, Marcelo Garcia.

**3. Research Category:**

Geomorphological and engineering analysis of bendway weirs

**4. Problem and Research Objectives:**

The purpose of this study is to conduct an integrated geomorphological and engineering evaluation of the performance of bendway weirs in streams in Illinois. The research will integrate a geomorphological analysis of bendway weirs supported by the Illinois Department of Natural Resources with an engineering-based assessment that uses numerical modeling of flow through bends with weirs to evaluate the impact of these structures on fluvial processes. The goal is to provide a wide-ranging, theoretically based evaluation of bendway weir performance for a variety of meander configurations. Specific objectives are: 1) to develop a general computational fluid-dynamics (CFD) model to accurately predict patterns of three-dimensional flow through meander bends with bendway weirs and 2) use field data collected as part of the IDNR-funded geomorphological assessment to test the predictive capabilities of the model developed in phase 1 for real-world cases.

**5. Methodology:**

The methodology will involve the development of a CFD model of flow through bends with weirs. The three-dimensional numerical model FLOW-3D will be adapted for this purpose. Once the model is developed and calibrated, the influence of bendway weirs of different types on flow through hypothetical meander bends of different configurations will be explored through a series of numerical simulations. Finally the model will be used to simulate flow through two real-world bends that contain bendway weirs: one site where weirs have effectively mitigated erosion and one site where the weirs have failed to mitigate erosion. Field data collected as part of the IDNR-supported study will provide the basis for developing these simulations and for evaluating predicted patterns of 3-D velocities relative to measured patterns of 3-D velocities

**6. Principal Findings and Significance:**

The first year of activities was devoted to extending the capabilities of STREMR, a 2-D depth-averaged flow model, so that it could handle sediment transport in rivers. In particular, the code is being generalized to handle suspended and bedload transport as well as bed level changes associated with sediment scour and deposition. Our goal is to be able to use the code to predict both hydrodynamic and morphological changes caused by bendway weirs in Illinois streams.

STRMR has been modified to include sediment transport (Garcia, 2001). Bed deformation is accounted for by means of the Exner Equation-sediment conservation equation. This equation has been implemented in the subroutine MAGIC of STRMR. Bed level changes are computed with the help of bedload transport rates and suspended

load rates. To estimate sediment entrainment rates, several different available transport functions can be used, depending on the characteristics of the stream being modeled.

The modified version of STRMR was used to model a bend of Sugar Creek at Brookside Farm, Illinois. This site is of particular interest since the Geomorphology group of Professor Bruce Rhoads has been conducting measurements around a bendway weir field. We are currently in the process of coupling the flow field with the sediment bed to predict potential sediment erosion and deposition areas within the bend.

Field work has produced data sets on three-dimensional flow through weir fields at three sites in Illinois – one along Big Creek in Clark County, one along Sugar Creek in McLean County and one along Kickapoo Creek in McLean County. All sets of measurements were obtained when flow was at or near the crests of the weirs at each site. These data provide the basis for field testing of the predictive capabilities of the STREMR model.

**References**

Garcia, M.H., Modeling Sediment Entrainment into Suspension, Transport, and Deposition in Rivers, Chapter 15 in Model Validation: Perspectives in Hydrological Science, Edited by Malcolm G. Anderson and Paul D. Bates, John Wiley & Sons, England, 2001.

**7. Graduate Students Supported with Funding**

<u>Name</u>	<u>Department</u>	<u>College</u>	<u>Institution</u>	<u>Degree Sought</u>	<u>Date Degree was or will be awarded</u>
Jorge D. Abad	Civil and Env. Engineering	Engineering	Univ. of Illinois	M.A.	Anticipated May 2003

**8. Publications and Presentations**

**9. Notable Achievements:**

The research is developing a state-of-the-art predictive tools that can be used to enhance the success of stream restoration.

**10. Related Seed Projects**

The research is a companion project to a grant to PI Rhoads from the Illinois Department of Natural Resources to develop a manual for geomorphological assessments of bendway weirs.