Report for 2002IL2B: Integrated Engineering and Geomorphological Analysis for Assessing the Performance of Bendway Weirs in Illinois Streams

There are no reported publications resulting from this project.

Report Follows:

Illinois Water Resources Center
Annual Report
Spring 2003

1. Project Number: 2002IL2B

2. Project Title and PIs: Integrated Engineering and Geomorphological Analysis for Assessing the Performance of Bendway Weirs in Illinois Streams; Bruce Rhoads, Department of Geography, Marcelo Garcia, Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign.

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 two-dimensional and 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 involves the development of a CFD model of flow through bends with weirs. Both 2-D and 3-D numerical models (STREMR and FLOW-3D) are being adapted for this purpose. Once the models are 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:

This research attempts to clarify some concepts, especially those related to fluid dynamics around weirs and sediment transport redistribution (mainly as bedload). A comparison between conditions with and without submerged weirs is necessary. This comparison can be achieved by numerical modeling of these two conditions. The numerical modeling can be done using a 2D depth-averaged model named “STREMR HySeD”, which calculates flow characteristics (hydrodynamics) as well as sediment transport (both suspended and bed-load

transport). However, flow patterns around submerged weirs are basically three-dimensional, therefore a 3D modeling would be done using a commercial program named "FLOW3D".

2-D Modeling

As preliminary result, the 2D modeling of one of the three sites has been done. A discharge of 1.0 m^3/s was assumed (this value is derived from field measurements). Two conditions are modeled. In the first condition, the weirs are not included (Figure 1), and in the second condition, the weirs are included (Figure 2). A mesh of 507 x 42 cells was used in both cases. In the second case the weirs were considered to be obstacles without porous characteristics, because according to field evaluation, for low flows, these weirs are not submerged. Further work during the summer 2003 will refine the 2-d modeling and complete 3-D modeling. Predictions will be compared with field data to evaluate model performance.

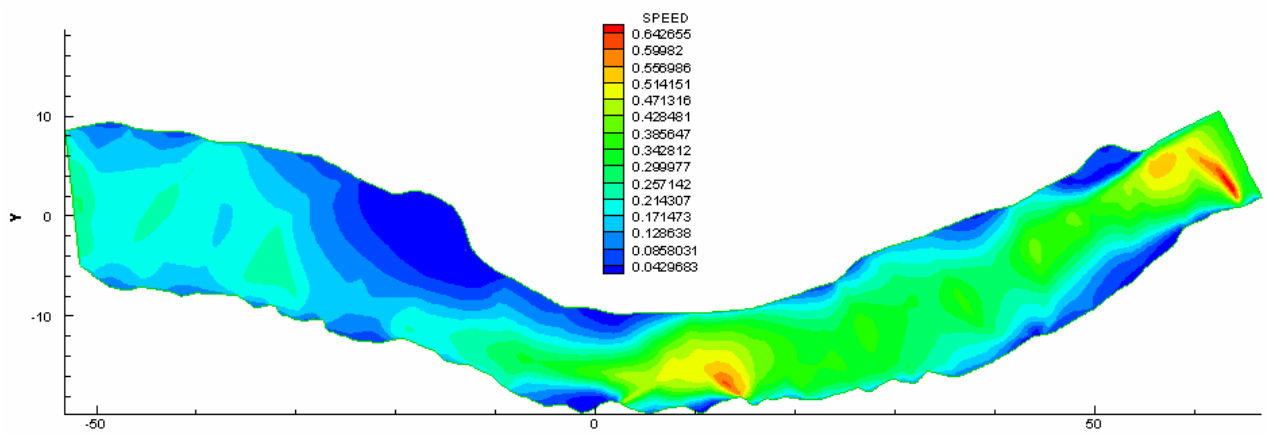

Figure 1: Hanlin site modeling without weirs

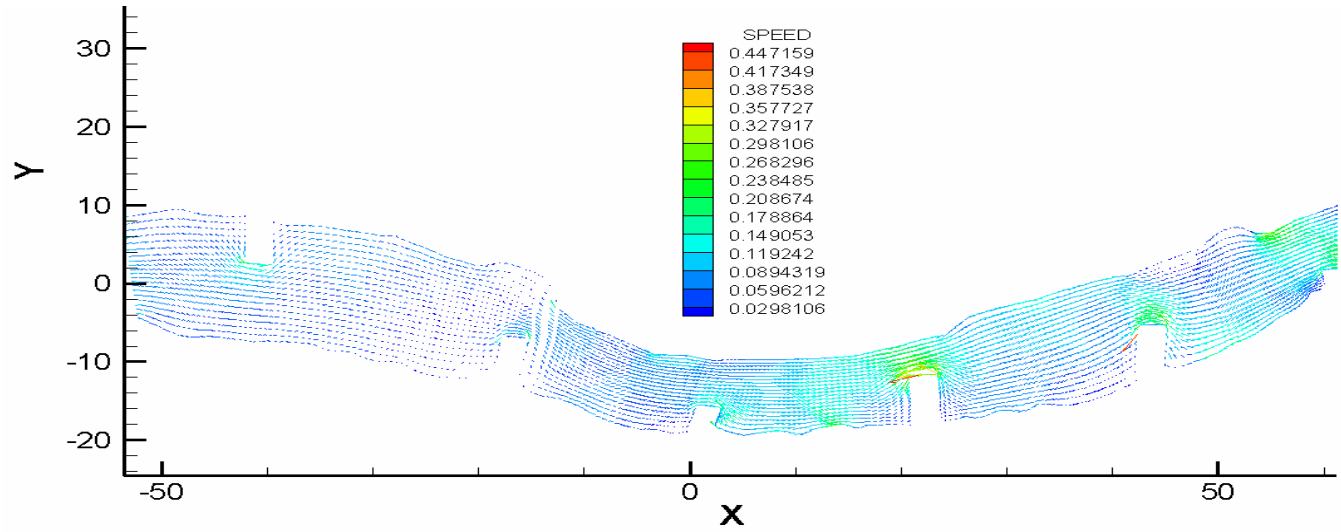

Figure 2: Hanlin site modeling with weirs

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. Analysis of field data is complete for two of the three sites and nearly complete for the third site. The analyzed data provide the basis for field testing the predictive capabilities of the 2-d and 3-D models.

7. Graduate Students Supported with Funding:

Name	Department	College	Institution	Degree Sought	Date Degree was or will be awarded
Jorge D. Abad	Civil and Env. Engineering	Engineering	Univ. of Illinois	M.S.	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.