USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2002IL2B

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

Project Type: Research

Focus Categories: Management and Planning, Surface Water

Keywords: streambank erosion, bendway weirs, fluvial geomorphology, hydraulic modelling

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Abstract

Streambank erosion is a critical water-related natural resource issues in Illinois, the Midwest and elsewhere in the United States. Recently, bendway weirs have become a popular structural approach to erosion control in meandering streams. Thus far, little scientific information is available on the influence of bendway weirs on stream dynamics. Although these structures have successfully mitigated bank erosion in some cases, the weirs have not performed as anticipated in all cases. Moreover, current design criteria are based primarily on expert judgment rather than formalized evaluative procedures based on scientific knowledge of the effects of weirs on fluvial processes. 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.

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. The proposed study will generate scientific information of the type needed to rigorously evaluate the influence of bendway weirs on stream dynamics. The modeling of three-dimensional flow through bends with and without weirs will indicate whether these structures alter patterns of flow in the manner inferred from qualitative, experimental evaluations of their performance. Because the modeling results will be compared with measurements of velocities at field sites, the results will not merely be theoretical, but will have an empirical grounding. The study will also yield information and a modeling tool that can serve as the foundation for determining whether weirs will perform effectively at particular sites and for optimizing the effectiveness of weir design for circumstances in which the installation of these features is deemed necessary. Because the results will be theoretically based, they should have broad relevance for streams in Illinois and in other parts of the Midwest.