Chapter 1

Decision Support for River Quality Management: The REKA Model in Bulgaria

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ABSTRACT

A decision support system linking a geographic-information-systems-based simulation of basin-scale water quality with a linear programming decision model for improving water resources management was developed using the Yantra River Basin in Bulgaria as a case study. This chapter describes the structure and purpose of the three model components of the River Environmental Knowledge and Assessment (REKA) model, focusing on challenges and solutions encountered in the building, parameterization, and testing of the model (particularly on issues of environmental data input), and reports on the difficulties in system implementation. Our intent is to inform other investigators of the kinds of problems encountered by the REKA research team (consisting of American and Bulgarian scientists), including challenges in locating and acquiring data and identifying and translating environmental parameters from the socialist scientific system to the conventions used in the West where basic model components originated. Instances of sparse and incomplete data and the processing to develop appropriate spatial and attribute data compatible with the model structure are presented. The chapter also speaks to the frustration of the research team and local environmental officials that the developed system could not be implemented for practical pollution management due to lack of funding for integrated practices and policy adoption.1

INTRODUCTION

A decision support system for improving water quality in river basins was developed using the Yantra River Basin in Bulgaria as a case study (Knight et al., 2002; 2007). The modeling system developed, REKA (River Environmental Knowledge and Assessment), linked a geographic-information-systems-based (GIS) simulation of basin-scale hydrologic response and water quality...
with a linear programming decision model that focused on water quality response to alternative strategies and investments for water treatment in different river reaches. As illustrated in Figure 1, the REKA model includes three components: BISTRA, which models water pollution from individual upland watersheds and is implemented using a GIS framework; VODA, which is an in-stream routing and load model and also the main economic optimization component; and PLAN, which is used to specify alternative water management actions that can be taken, goal achievement, and presentation of resultant outcomes of water quality status along river reaches. The component names are explained in Figure 1.

Overall, the REKA model was designed to answer two kinds of questions: 1) to attain a certain level of pollution reduction for a given river reach or reaches, what least-cost alternative management strategies could be implemented given various probabilistic levels of stream flow, variable climate conditions, and/or community-based priorities, or 2) given a certain amount of funds to be targeted for control, where should these funds be invested to have the greatest impact on water quality? For purposes of water resources planning, the modeling system was designed to accept inputs of climate and land use change, as well as alternative treatment and management alternatives. REKA was developed as a transferable GIS-based system to link process and decision models related to water quality in a comprehensive basin framework.

In this chapter we briefly present the three modeling components and describe the various challenges encountered in building the model, locating and interpreting relevant data sources, identifying community-based policy alternatives, and implementing the system. Through this case study we demonstrate that a working, practical decision support system (DSS) for basin-scale analyses of water quality management can be developed, and that difficulties and impediments in transferring modeling approaches from “data-rich and data available” cases to “data challenged” situations can be accomplished. The DSS elaborates and links various existing model components, conceived and previously applied in “developed” countries, into a comprehensive system. Here, the reader can see how the various components were developed and applied based on data available in Bulgaria.

Our specific objectives are: a) to briefly describe the linked model developed for basin scale modeling, with the Yantra Basin as a case study, b) to discuss the overriding difficulties in identifying, locating, acquiring, and processing a GIS dataset for the model, c) to describe specific data needs and the challenges in “adapting” available data to establish system parameters, d) to discuss the implications of limited data availability for calibration, d) to describe the economic and water management aspects of the decision-support model, and e) to discuss implementation and adoption difficulties for the model in a case where limited resources and commitment for adoption are problematic.

**Figure 1.** The REKA model structure consisting of three primary components BISTRA, VODA, and PLAN (diagrammed using Cmap, by IHMC (2009)) Copyright © 2009 REKA Project Team; used by permission
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