Report as of FY2007 for 2006NV103B: "Hydrodynamic Modeling of Lake Mead"

Publications

Project 2006NV103B has resulted in no reported publications as of FY2007.

Report Follows

Progress Report for Hydrodynamic Modeling of Lake Mead (2006NV103B)

PI: Mark Stone
June 15, 2007

Problem and Research Objectives

Lake Mead is one of the most important water bodies in the United States; providing recreational opportunities, fish and wildlife habitat, and drinking, irrigation, and industrial water for approximately 25 million people. Consequently, it is crucial that the quality of this water be maintained to provide a reliable and safe source of water for its many uses. Rapid urban development in Southern Nevada, combined with modified upstream land use and extended drought, has gradually degraded Lake Mead water quality. This problem was demonstrated by an intense algal bloom throughout Boulder Basin in the spring of 2001. Concerns over water quality were the impetus for intensive sampling efforts conducted by the U.S. Bureau of Reclamation (USBR), the Southern Nevada Water Authority (SNWA), the U.S. Geological Survey (USGS), and others in Lake Mead over the past 15 years. Although the monitoring efforts have provided an outstanding record of spatial and temporal circulation and water quality trends, this data has not been incorporated into a unifying tool to support management and research efforts. *The goal of this research is to develop an ecological model of Lake Mead to investigate circulation and eutrophication of the lake*. The model will integrate previous water monitoring efforts, improve understanding of lake circulation, and provide the framework for a robust adaptive management tool for Lake Mead.

Methodology

The final product of this research will be an ecological model capable of investigating the influence of abiotic parameters on eutrophication and algal blooms. The following tasks are underway to produce the model.

1. Review existing models and data

A number of ecological models exist which are capable of simulating eutrophication processes ranging from complex biogeochemical models, which are often coupled with 2- or 3-D hydrodynamic models, to simple empirical relationships based on observations. We conducted an extensive review of the models available for this purpose and compared their capabilities and data requirements with the objectives of this project and available data.

The Bureau of Reclamation, USGS, and SNWA have been collecting a wide range of environmental data on Lake Mead over the past 15 to 20 years. As one of the first stages of this research, we reviewed the reports and publications resulting from these monitoring efforts. We have requested the available data necessary for developing the ecological model.

2. Select ecological model

We initially planned to base our model on a biogeochemical approach, but have changed courses to use a structurally dynamic approach. Structurally Dynamic Models (SDM) are based on an evolutionary framework in which the productivity and community composition are determined through goal functions of optimal biomass or exergy. For this project, we will be customizing the SDM PAMOLARE (Planning And Management Of Lakes And Reservoirs focusing on Eutrophication) developed by the United Nations Environmental Program.

3. Parameterize the model

We have received a portion of the requested data necessary for parameterizing the PAMOLARE model. This data has been incorporated into the model for several short time spans. We are expecting to receive several additional datasets in the near future from the USGS and Bureau of Reclamation. Further, several parameters necessary for the model are not available through existing models. We plan to collect the additional field data from Lake Mead by the end of this summer.

4. Calibrate the ecological model based on historical data

Like other environmental models, the PAMOLORE model has a large number of parameters which can be adjusted within a suitable range to better reproduce historical datasets and improve overall model performance. Fortunately, the extensive monitoring activities in Lake Mead provide an excellent calibration dataset. We will use 5 to 10 years of the historical dataset to calibrate the model. We will then use the additional historical data to validate the model under different environmental conditions (i.e. lower water levels).

5. Evaluate system response to environmental conditions

Following model calibration and validation, we will be able to evaluate how the model responds to various environmental conditions. For example, we will evaluate the impact of increased nutrient loads and lower water depth on primary production.

6. Identify environmental thresholds for algal blooms

A priority for Lake Mead managers is to prevent the reoccurrence of a major algal bloom like the one that occurred in 2001. Algal blooms occur as a response to appropriate environmental conditions in which lead to exponential algal growth rates. We will attempt to identify such environmental thresholds.

Additionally, in January of 2007 the invasive quagga mussel was identified for the first time in Lake Mead. This aggressive invasive species can have severe environmental

consequences including short-circuiting by overgrazing algae. We will also attempt to evaluate the potential ecological consequences of this emerging issue.

Principal Findings and Significance

The only finding of this research to date has come as a result of reviewing data from previous monitoring activities. We have determined that the lake is P limited and that a threshold concentration for severe algal blooms appears to be at approximately .05 mg/L. We also have found that the lake fully mixed in approximately 60% of the years of record. As data from the past 4 years is not yet available, we have not been able to identify the impacts of dropping water levels.

The ecological model is still in its developmental stages and therefore we have no findings to report. We anticipate having an operational model by this fall.

Information Transfer Activities

The project is still underway and therefore has not yet been published in any fashion. Outcomes from the initial data review have been discussed with limnologists at SNWA and with resource managers at the Bureau of Reclamation. We expect to publish the final study results in at least one peer-reviewed journal paper and to present the results at one or more professional conferences. We also hope to present the results to the Lake Mead Water Quality Forum.

Student Support

This project was initially delayed by the inability to recruit a graduate student. Consequently an undergraduate student, *Mahsa Amirsarhangpour*, was hired to work on the project in October of 2006. Mahsa has performed at a very high level and I'm hopeful that she will continue this project as a Masters student in the spring of 2008.