Quantifying Sediment Resuspension Linkages to Nutrient Enrichment in the Existing and Future Salton Sea

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Three sediment resuspension models representing sediment characteristics were combined into a hydrodynamic and water quality model, DLM-WQ. The resulting models were applied to the Salton Sea, a shallow, wind-dominated, highly saline and eutrophic, terminal lake. The output of each water quality model is compared with measured data by using statistical and graphical evaluation methods. Based on these comparisons, DLM-WQ with an extended version of the García and Parker (1993) relationship gave the best match to the measured data. The resulting model simulation confirms that sediment resuspension is the most dominant process in the Salton Sea's nutrient cycling. The effect of proposed physical changes to the Salton Sea on water quality characteristics is presented.

The Salton Sea is a shallow, wind-dominated, terminal lake located in the southeastern desert of California (Figure 1). The Sea is a highly saline, eutrophic water body, characterized by high nutrient concentrations, high algal biomass as demonstrated by high chlorophyll *a* concentrations, high fish productivity, low clarity, frequent very low dissolved oxygen concentrations, massive fish kills, and noxious odors. However, the Salton Sea provides important habitat for large numbers of migratory bird species, of which some are threatened and some are endangered. Furthermore, sediment characteristics of the Sea (sediment cohesiveness in particular) are difficult to characterize as the sediments can exhibit a range of characteristics between cohesive and non-cohesive.

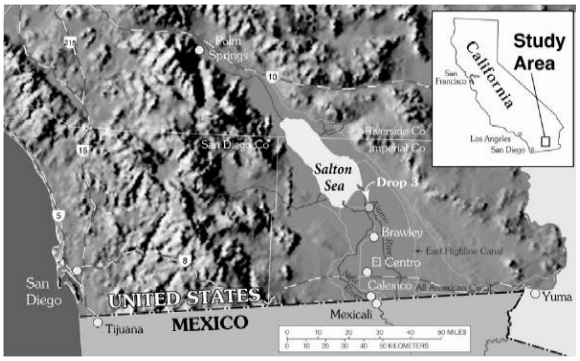

Figure 1. Salton Sea basin and surrounding area of California, U.S.A. and Mexico.

The physical size of the Sea will be significantly reduced in response to major inflow diversions that are planned under the Colorado River Quantification Settlement Agreement (QSA). The California Department of Water Resources (DWR) and California Department of Fish and Game (DFG) developed and proposed eight morphological alternatives to restore important ecological functions to the Salton Sea.

The relation between the sediment resuspension and the nutrient cycles of the Sea has been modeled by using a hydrodynamic and water quality model, Dynamic Lake Model – Water Quality (DLM–WQ), combined with the empirical sediment resuspension model of Somlyody (1986) which makes no provision for variable sediment characteristics.

In this research, we combined three other sediment resuspension models into DLM-WQ, and then applied them to the Salton Sea. The three sediment models represent different sediment characteristics, for

example Mian and Yanful (2004), a linear relation between sediment erosion rate and suspended sediments for cohesive sediments and an extended relation of García and Parker for non-cohesive sediments.

The output of each water quality model is compared with measured data by using statistical and graphical evaluation methods. By these comparisons, DLM-WQ with the extended relation of García and Parker, originally developed for open channel flows, was considered the best model for resolving both the seasonal trends and the short-term variations of most water quality variables of the Salton Sea. The model simulation confirms that nutrients in both particulate and dissolved forms (from sediment porewater) induced by sediment resuspension are presently the most important factor in the Sea's nutrient cycling.

To explore the effect of changes of morphology on the water quality of a future Salton Sea, we selected two of the alternatives that have been proposed by DWR and DFG for the Salton Sea: the North Sea Combined and South Sea Combined (see Figure 2). The DLM–WQ, with the extended formula of García and Parker, was employed to simulate water quality characteristics of these two alternatives. In both alternatives, the anoxia in the hypolimnion in the summer would be spatially and temporally increased due to an increase in the length of the stratification period, during which toxic substances and organic materials could accumulate in the sediments.

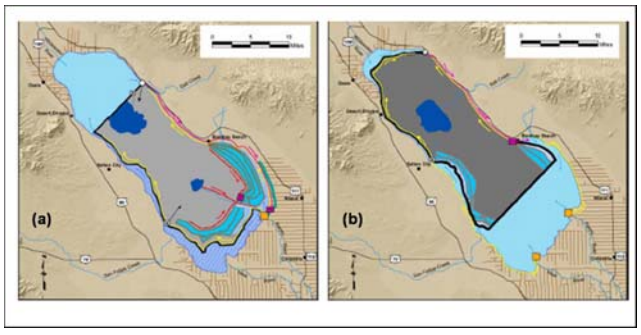

Figure 2. Two alternatives proposed for a future Salton Sea by DWR and DFG: (a) North Sea; (b) South Sea.

Publications

Chung, E. G., F. Bombardelli, S. G. Schladow, 2007. Modeling Linkages between Sediment Resuspension and Water Quality in a Shallow, Eutrophic Lake: Statistical Comparison of Sediment Resuspension Models. *Ecological Modeling,* submitted.

Chung, E. G., F. Bombardelli, S. G. Schladow, 2007. Sediment Resuspension in a Shallow Lake. *Water Resources Research*, submitted.

Chung, E. G., S. G. Schladow, J. Perez-Losada, D. M. Robertson, 2007. A Linked Hydrodynamic and Water Quality Model for the Salton Sea. *Hydrobiologia*. In press.

Selected Professional Presentation

Chung. E.G., F.A. Bombardelli, and S.G. Schladow. 2007. Influence of sediment resuspension in a shallow, eutrophic lake. The Fifth International Symposium on Environmental Hydraulics. University of Arizona, Tempe, AZ.

Collaborative Efforts

This research is providing input toward the ecological restoration the Salton Sea. This restoration is currently under investigation by the California Department of Water Resources and the US Bureau of Reclamation. We are working closely with staff from both agencies, as well as staff from the California Department of Fish and Game. We are also collaborating with the USGS and NASA on Salton Sea related issues. We have also established an ongoing collaboration with Dr. Francisco Rueda of the University of Granada, Spain.

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