

Sustainable eco-systems under land retirement

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EXECUTIVE SUMMARY:

Sustained irrigation practice is crucial to the San Joaquin Valley which contributes 50 percent of the state's agriculture revenue. The absence of adequate drainage due to topographic and environmental constraints has forced the western San Joaquin Valley to tackle problems of shallow water tables with high salinity in general and specific toxic trace elements in particular. In 1990, the San Joaquin Valley Drainage Program (SJVDP) produced a report outlining six possible steps to address the drainage issue (SJVDP, 1990). The retirement of irrigated agriculture lands was one of the six recommended in the report. Land retirement is the intentional discontinuation of irrigation over specified areas so as to reduce the shallow water table beneath those areas, reduce the volume of drainage generated and also reduce the total salt load in the drainage water. An additional benefit is that water that would have been applied for irrigation becomes available for other uses. With land retirement in the western San Joaquin Valley, it was expected that, instead of contributing to their contamination, the dewatered area beneath the retired lands would also act as a sink to receive some contaminated water from adjacent lands. Subsequent studies have underscored the necessity of conducting studies to evaluate the fate of salts present in the soil profile at the time of land retirement, suitability of the retired lands for other uses such as habitat development and the environmental consequences of various land retirement scenarios. A follow-on San Joaquin Valley Drainage Implementation Program (SJVDIP, 1999) conducted a review of key components of the SJVDP (1990) recommendation plan. A land retirement technical committee of the SJVDIP (1999) reevaluated and updated the 1990 land retirement plan. In the study by the technical committee, hypothetical and actual land retirement strategies were developed and their effects on biologic, hydrologic and soil systems measured and modeled. The 1999 report of the SJVDIP subcommittee on Land retirement has identified four areas of concern related to Hydrologic, Biological, Pedologic and Economic effects of land retirement, whose long term and short term consequences need careful consideration. Retired land could be used to develop native plants which then may be conducive to the growth of wildlife. However, there is also a possibility of land retirement causing negative effects such as excessive accumulation of trace elements and salts on the land surface and the establishment of undesirable weed communities. Excessive salt accumulation might result in little or no plant growth and vegetation cover causing wind blown salt problems downwind. The results of hydrologic and soil modeling studies indicated that without implementation of special management

techniques, there is serious danger of retired lands becoming excessively salinized and seleniferous. A comprehensive study on this aspect of land retirement is needed to develop a science based management strategies for retired lands that will minimize the negative consequences and will optimize the post use benefits of the retired land use especially for wildlife habitat uses.

With an aim to achieve the above stated goals, the objective of this study is to develop necessary tools to aid in the evaluation of land retirement and its consequences related to hydrologic, pedologic and habitat impacts with a view to minimize its negative impacts while optimizing the post use benefits. The specific objectives are to:

1. Calibrate, validate and apply an existing proven numerical model to simulate major processes occurring in the land phase of the hydrological cycle. The model simulates unsaturated-saturated water flow and solute transport, subject to root water uptake.
2. Evaluate and recommend land retirement management strategies that will promote/maintain a sustainable agriculture production system in the region.
3. Evaluate and recommend land retirement management strategies that will promote a sustainable eco-system.
4. Use GIS to display the salt loading, soil salinity profiles, shallow groundwater levels, and habitat conditions as a result of different management choices.

We propose to use MIKE SHE software program, which is a physically based, spatially-distributed, finite difference, integrated surface water and groundwater modeling system for the simulation of major hydrologic processes occurring in the land phase of the hydrologic cycle. MIKE SHE utilizes three methods to simulate flow in the unsaturated zone but assumes that flow is vertical in all three methods. Once infiltrated water enters the surficial aquifer, the 3D ground water equations takeover. One of the available unsaturated zone methods is the full Richard's equation. The Richard's equation methods use soil properties and soil moisture-relationships. It includes a 3D saturated zone model. Available boundary conditions are comparable to those available in MODFLOW. Water quality in the unsaturated and saturated components can be explicitly modeled with MIKE SHE. An additional advantage with MIKE SHE is that it can be fully integrated with GIS applications.

The control volume for the study will consist of the vadose zone including the crop root zone and the saturated zone. The saturated zone itself is separated by the Corcoran clay layer into semi confined and confined zones. The vadose and saturated zones will be treated as the subsystem components and the combination of these two as the overall system. The study will be conducted at two different scales, regional and local. The regional hydrologic model consisting of confined, semi confined and clay layers will be characterized and calibrated using previous works of Belitz and Philips (1992), Wu et al (1998), Purkey (1998) and Fio (1999). The study of interaction between shallow water tables and upward flux to the rootzone together with the solute transport will be done at the local scale. The work by Islam (2004) of our laboratory which related to soil water uptake simulation using MIKESHE to determine water content will be used in the study. The study is relevant to us and we shall be using a similar model set up to study the interaction between upward fluxes, solute movement and types of crops or native plants. Apart from the soil physical properties (e.g., pore size distribution, bulk density etc)

which determine the value of soil hydraulic function parameters, a reliable estimate of the root water extraction function is required. The root water extraction function for crops is easily available in the literature, but the same may not be the case for native plants. We propose to use the study done under 'Land Retirement Demonstration Project' and from the literature to determine the root water extraction function for different native plants. The model will be used to evaluate the consequences of land retirement based on scenarios given in the final report of land retirement technical committee (SJVDIP, 1999). The evaluated consequences will be used to recommend management strategies to achieve the goal of a sustainable agricultural production system and a sustainable ecosystem.