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Sustainable irrigation management of drainage impaired area with 'Natural Drainage'

Principal Investigators:

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Project Summary

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. The Bureau of Reclamation, under Court Order, is to provide drainage service to the area so as to maintain a long-term, sustainable salt and water balance in the root zone of irrigated lands, sufficient to ensure sustainable agriculture in the region. In March 2007, the Bureau of Reclamation decided to implement a combination of drainage reduction measures, drainage water reuse, evaporation ponds and land retirement in what it calls the In-Valley/Water Needs Land Retirement Alternative.

The retirement of irrigated agriculture lands is one of the main components of the plan. In response to concerns about the lack of scientific data to identify potential benefits and impacts of retiring land from irrigated agriculture, a multi-agency team consisting of representatives from the Bureau of Reclamation (USBR), United States Fish and Wildlife Service (FWS), and the Bureau of Land Management (BLM) completed a five-year, large scale Land Retirement Demonstration Project (LRDP) at two drainage–impaired sites on the west-side of the San-Joaquin Valley. Based on the five years of field data from the LRDP, Singh et al. (2009) developed a comprehensive theoretical and numerical modeling framework to evaluate the specific site conditions required for a sustainable land retirement outcomes based on natural drainage.

The works of Singh et al. (2009) show the pathway to reducing the salinity levels without the encroachment of the shallow water table in the root zone. The results can be applied more broadly to the drainage management of drainage impaired lands. If the crop and irrigation is managed for salt balance such that leaching is constrained to match the natural drainage rate (defined as the downward flux from the shallow water table to the lower aquifer), the danger of rising water table is avoided. Singh et al. (2009) proposed a ‘natural drainage approach’ to sustainable land management for drainage impaired areas. With this approach it is feasible to design a sustainable land use regimen for drainage impaired lands in general and retired lands in particular. The key to the natural drainage approach is a priori knowledge of the relationship between the natural drainage rate and the depth to the water table from ground surface.

The proposed study aims to use the 'natural drainage approach' for sustainable irrigation management of drainage impacted areas. With an aim to achieve the goals, the main objective of this study is to:

a. Improve and update the numerical modeling framework of Singh et al. 2009 to simulate major processes occurring in the land phase of the hydrological cycle.

b. Evaluate and recommend sustainable irrigation management strategies for the drainage impacted area with 'Natural Drainage" approach.

The drainage impaired sites are characterized by the presence of a barrier layer which divides the perched water layer from the unsaturated flow zone below the barrier layer. We are evaluating five processes occurring in the land phase of hydrologic cycle. The processes that are modeled include the evapotranspiration, unsaturated and saturated flow and the downward flux through the barrier layer. Solute transport in both the unsaturated and saturated zone is also evaluated to quantify the changes in soil salinity in the vadose zone.

The relation between the bottom flux and the groundwater head is the tool that allows one to estimate the natural drainage rate for the given site. The natural drainage rate is the main parameter that impacts the management option for the sustainable land use of the drainage impaired lands. The land use and water application practices are two of the main variables which can be changed to make sure that water table depth never rises above a predetermined level and the root zone salinity levels are maintained within a permissible level. To achieve these two objectives, the following options may be pursued during the simulation exercise, a) change in the land use, crop type, b) growing crops in only a part of the area each year, and c) intersperse dry land farming with other farming activities.

The evaluated natural drainage rate can be used to develop a sustainable irrigation management of drainage impaired area. The developed model and its use will be shared with the concerned stakeholders such as Bureau of Reclamation (USBR), United States Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM), Land Retirement Demonstration Project, and the concerned water districts.

Student Support table

	Students Funded Through This Project		Supplemental Awards	**Total**
	Federal Funding	State Funding		
Professional Researchers	0	1	0	**1**
Masters Students	0	0	0	**0**
PhD. Students	0	0	0	**0**
Acad. Coordinator	0	0	0	**0**
Other Acad./Researchers	0	0	0	**0**
Professor/summer	0	0	0	**0**
Total	0	1	0	**1**