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DESIGN CHALLENGES TO THE INTEGRATION OF ECOSYSTEM SERVICES INTO AGRICULTURAL LANDSCAPES IN ARID ECOSYSTEMS

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ABSTRACT The San Joaquin Valley of California has an arid to semi-arid climate characterized by very dry summers. The landscape of the San Joaquin Valley has been transformed on a regional scale from seasonal wetlands and grasslands to intensively managed agriculture. There is significant interest in restoring ecosystem services to the San Joaquin Valley and using natural systems to mitigate widespread negative impacts from agricultural activities, including eutrophication of surface waters. In this paper we discuss the nature of diffuse pollution in the San Joaquin Valley and evaluate the design challenges that are faced for the engineering of ecosystem services into the agricultural landscape. The regional climate is characterized by annual rainfalls between 25 and 30 cm with average summertime (July-August) rainfalls of less than 0.1 cm per month. Stream flows, however, are highest in the summer and lowest in winter months, due to the influence of agricultural activities on flow. Flow and water quality were measured in multiple watersheds over several years. Flow, specific conductance, and temperature were measured continuously at key tributaries along the San Joaquin River. Continuous data was supplemented with intermittent measurement of water quality parameters, including organic constituents and nutrients. Geographical information systems were used to relate landscape activities to flow and water quality outcomes. Analysis of continuous flow data demonstrated that flow from agriculturally dominated drainages was not normally distributed and could fluctuate widely on a daily and seasonal basis. Water quality was not flow dependent, was typically not normally distributed, and could be related to landscape activities in individual watersheds. Design of treatment and mitigation wetlands in arid agricultural environments will need to incorporate features to respond to the unique constraints imposed by intensively agricultural systems that are dependent on irrigation for high production rates. Analysis of land area requirements for integrating wetland systems into the agricultural landscape for the purpose of mitigating diffuse pollution impacts indicates that sufficient land exists for restoring ecosystem services without negatively effecting economic production. Design criteria for implementation of ecosystem services in the San Joaquin Valley will be presented and discussed.

Keywords: wetlands, diffuse pollution, agriculture, ecosystem services