

**Title:** Evaluation of Arroyo Channel Restoration Efforts using Hydrological Modeling: Rancho San Bernardino, Sonora, MX

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**Publication:** American Geophysical Union, Fall Meeting 2012, abstract #EP31A-0790

**Publication Date:** 12/2012

**Origin:** [AGU](#)

**Keywords:** 1821 HYDROLOGY / Floods, 1825 HYDROLOGY / Geomorphology: fluvial, 1847 HYDROLOGY / Modeling, 1860 HYDROLOGY / Streamflow

**Bibliographic Code:** [2012AGUFMEP31A0790J](#)

## Abstract

In the drylands of the southwestern U.S. and northwestern Mexico, historical river channel incision (arroyo cutting) has led to the destruction of riparian ecological systems and *cieñega* wetlands in many locations. Along Silver Creek on the Arizona-Sonora border, the Cuenca Los Ojos Foundation has been installing rock gabions and concrete and earthen berms with a goal of slowing flash floods, raising groundwater levels, and refilling arroyo channels with sediment in an area that changed from a broad, perennially wet *cieñega* to a narrow sand- and gravel-dominated arroyo channel with an average depth of ~6 m. The engineering efforts hope to restore desert wetlands, regrow riparian vegetation, and promote sediment deposition along the arroyo floor. Hydrological modeling allows us to predict how rare flood events interact with the restoration efforts and may guide future approaches to dryland ecological restoration. This modeling is complemented by detailed topographic surveying and use of streamflow sensors to monitor hydrological processes in the restoration project. We evaluate the inundation associated with model 10-, 50-, 100-, 500-, and 1,000-year floods through the study area using FLO-2D and HEC-RAS modeling environments in order to evaluate the possibility of returning surface inundation to the former *cieñega* surface. According to HEC-RAS model predictions, given current channel configuration, it would require a 500-year flood to overtop the channel banks and reinundate the *cieñega* (now terrace) surface, though the 100-year flood may lead to limited terrace surface inundation. Based on our models, 10-year floods were ~2 m from overtopping the arroyo walls, 50-year floods came ~1.5 m from overtopping the arroyos, 100-year floods were ~1.2 m from overtopping, and 500- and 1,000-year floods at least partially inundated the *cieñega* surface. The current topography of Silver Creek does not allow for frequent flooding of the

former cieñega; model predictions indicate that inundation would only occur in rare events with a ~500 year recurrence interval. In addition, by updating modeling as restoration efforts change the stream bed depth and valley geometry, we can quantify the effects of the restoration effort on surface hydrology. Local bed aggradation upstream of gabion and dam structures occurs in smaller floods, and if carefully planned and managed, could lead to wider flood inundation as the channel is able to reintegrate with the former floodplain.