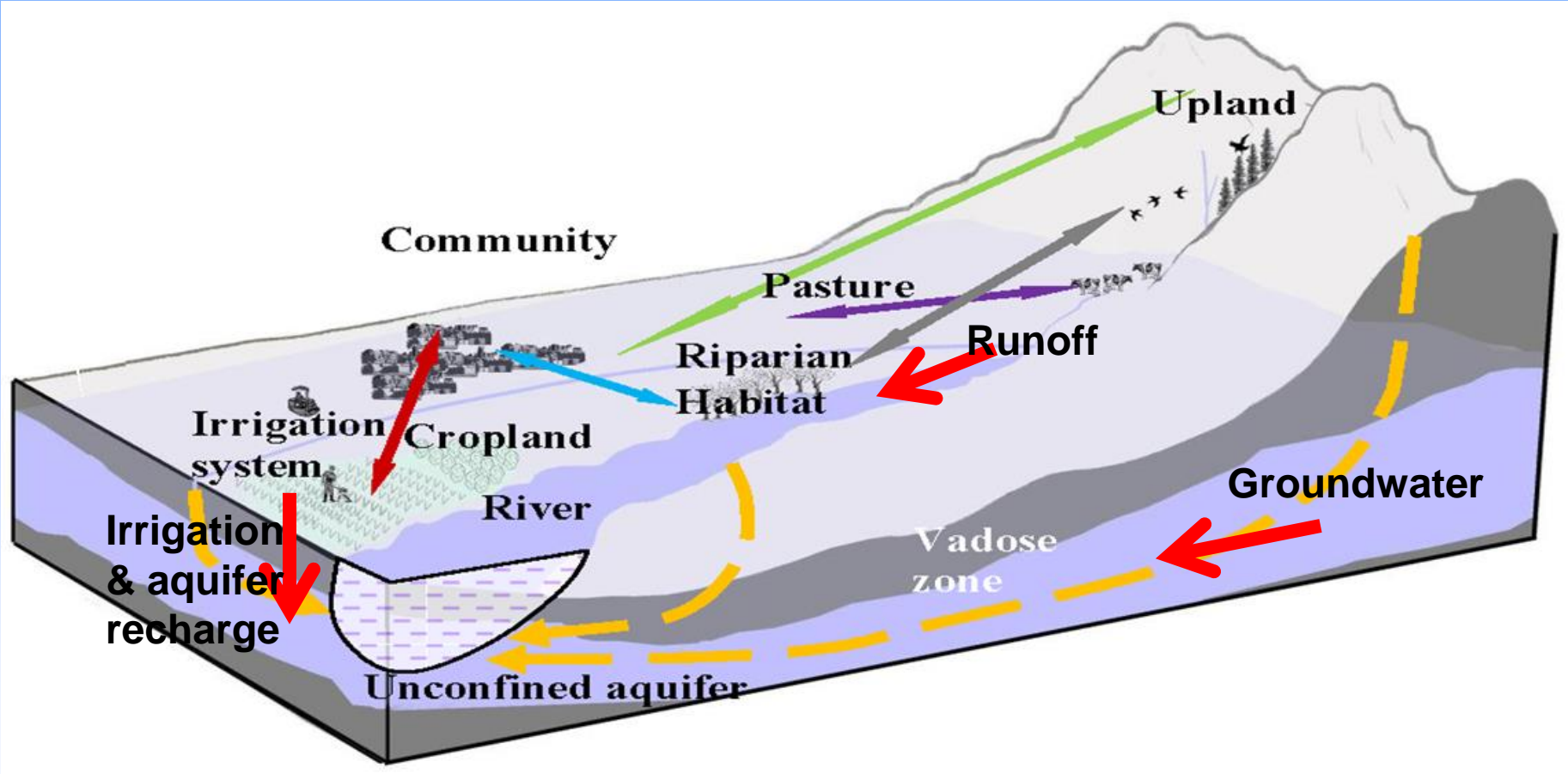


Monitoring and Modeling Hydrologic Connectivity in Semiarid Watersheds

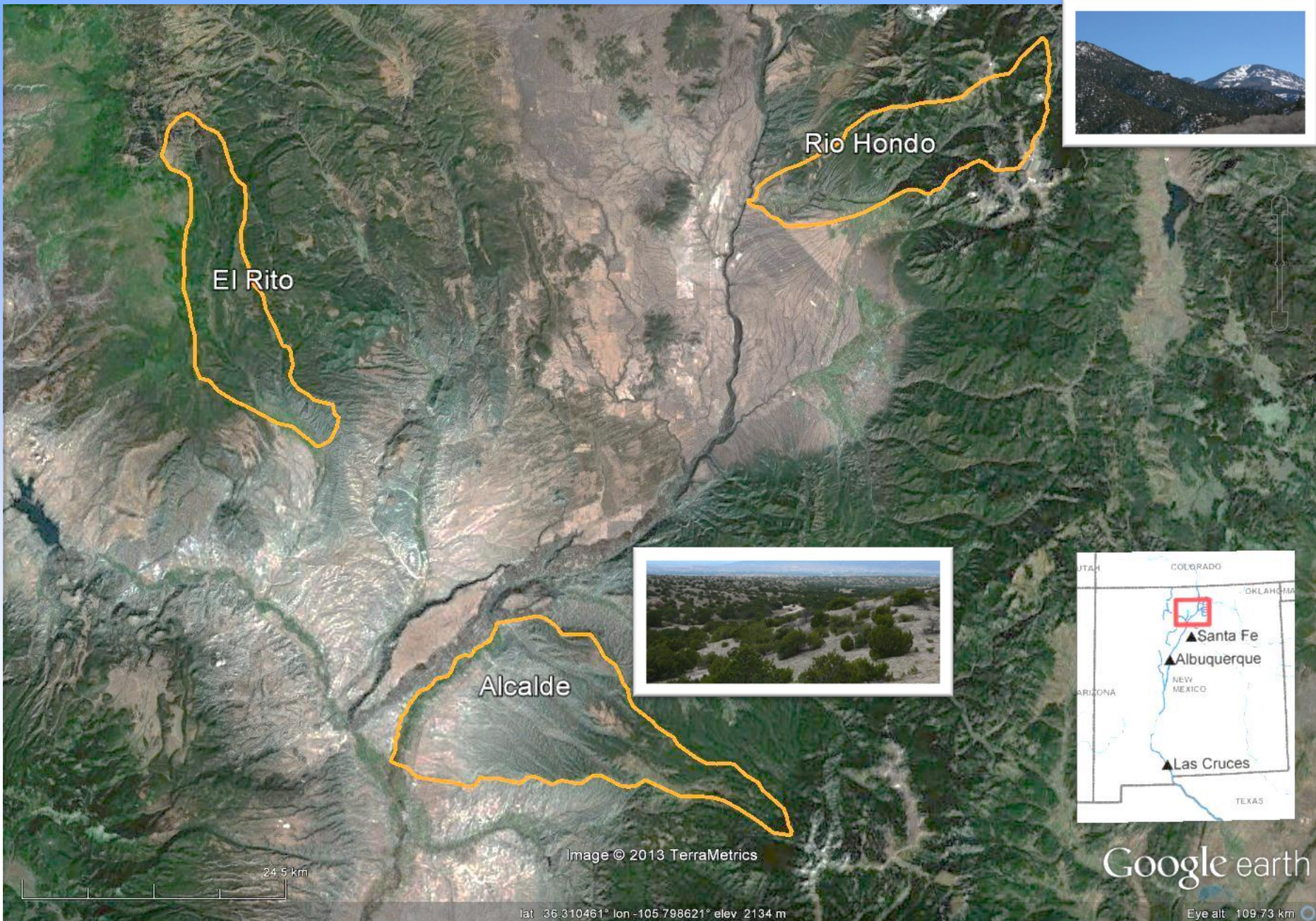
New Mexico State University

Carlos Ochoa

- Looking at hydrologic connectivity between the headwaters and the irrigated valley.



Study sites



El Rito

Rio Hondo

Alcalde

Image © 2013 TerraMetrics

Google earth

lat 36.310461° lon -105.798621° elev 2134 m

Eye alt 109.73 km

Field data collection

Different water budget components are being measured.



Field data collection cont'd

- Multiple weather and hydrologic parameters are being monitored.



Soil moisture/soil properties



Soil moisture/deep percolation



Weather



Shallow groundwater

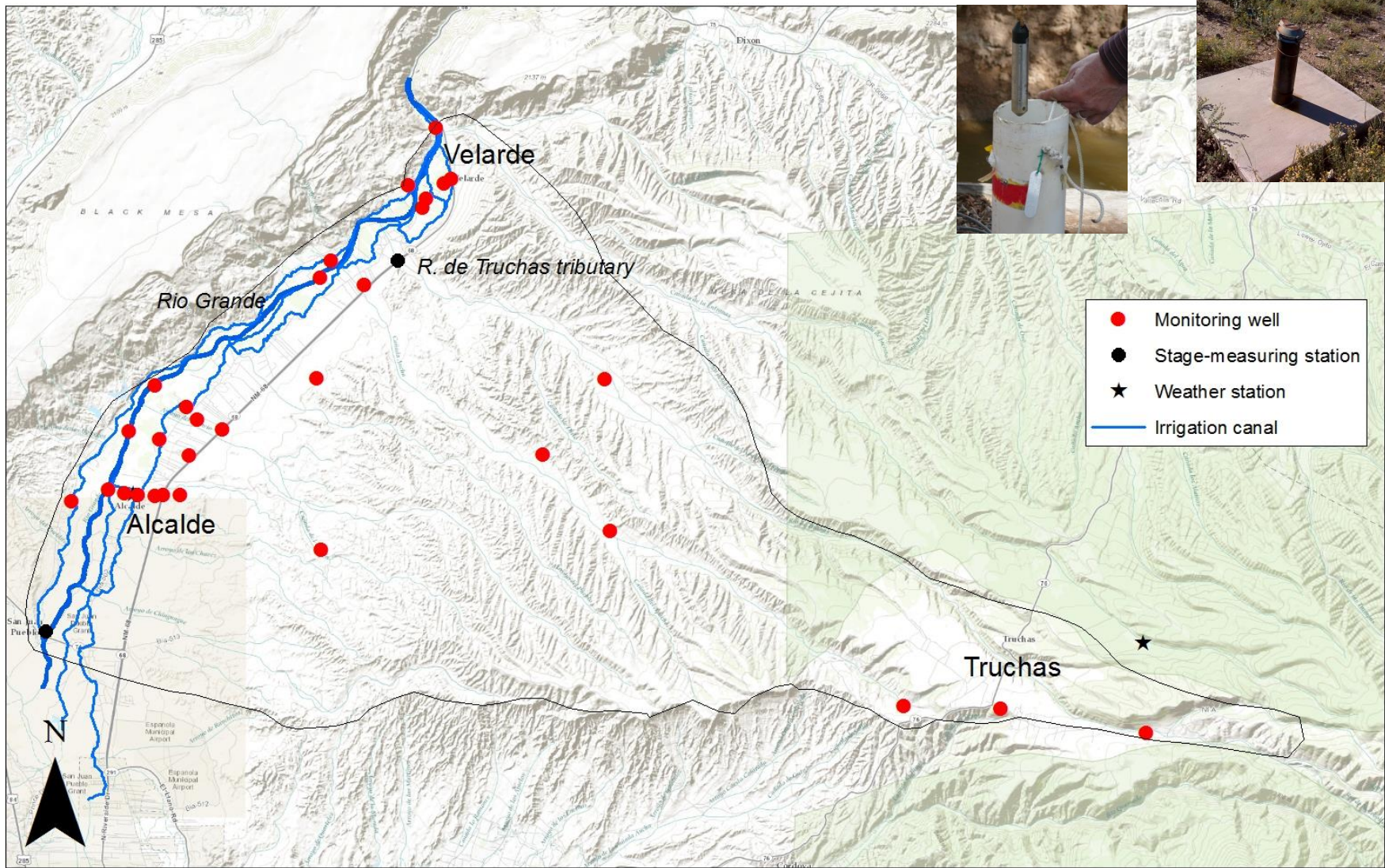


Stream flow



Acequia stage/flow

Surface water and groundwater connectivity – Alcalde site

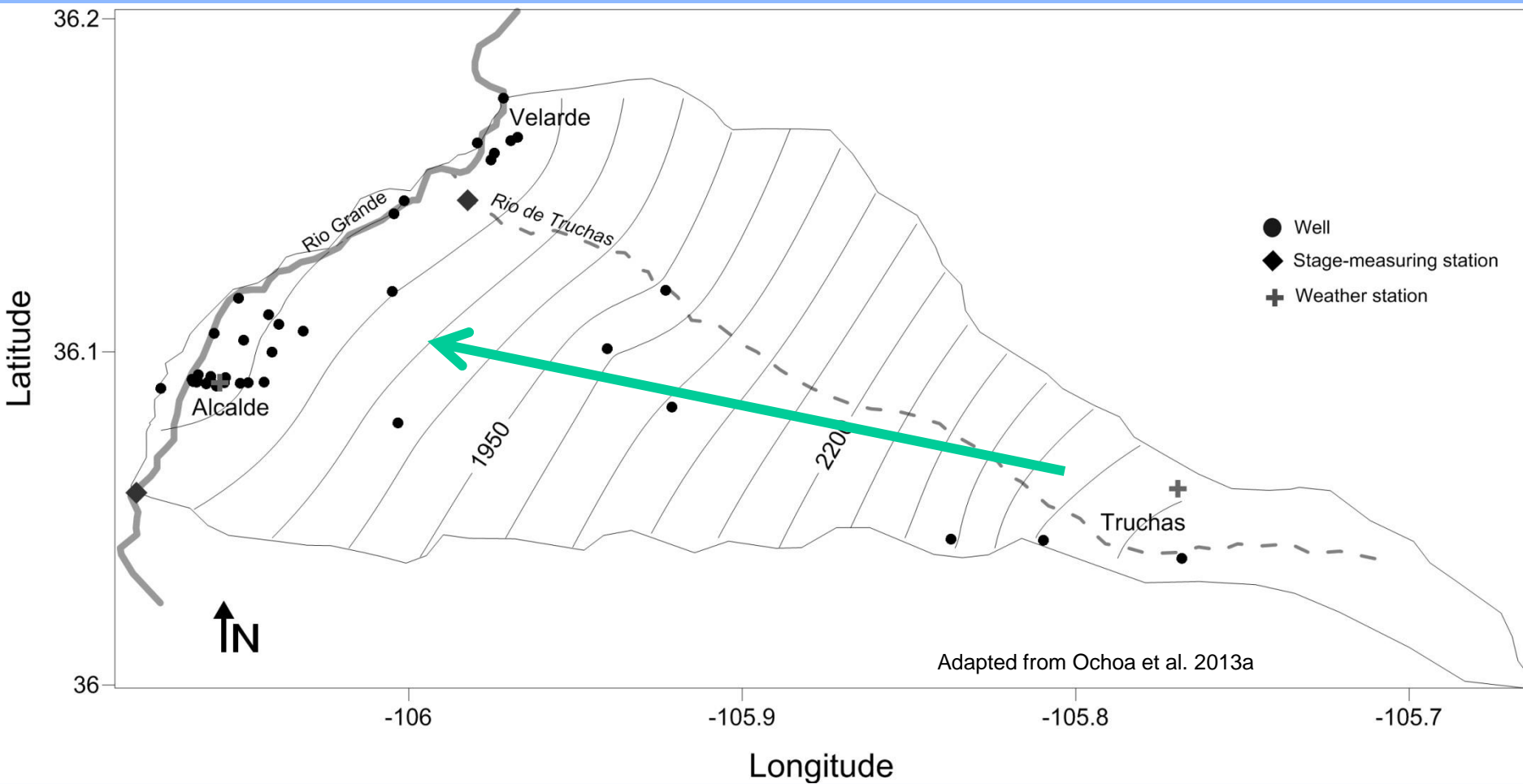


12,000

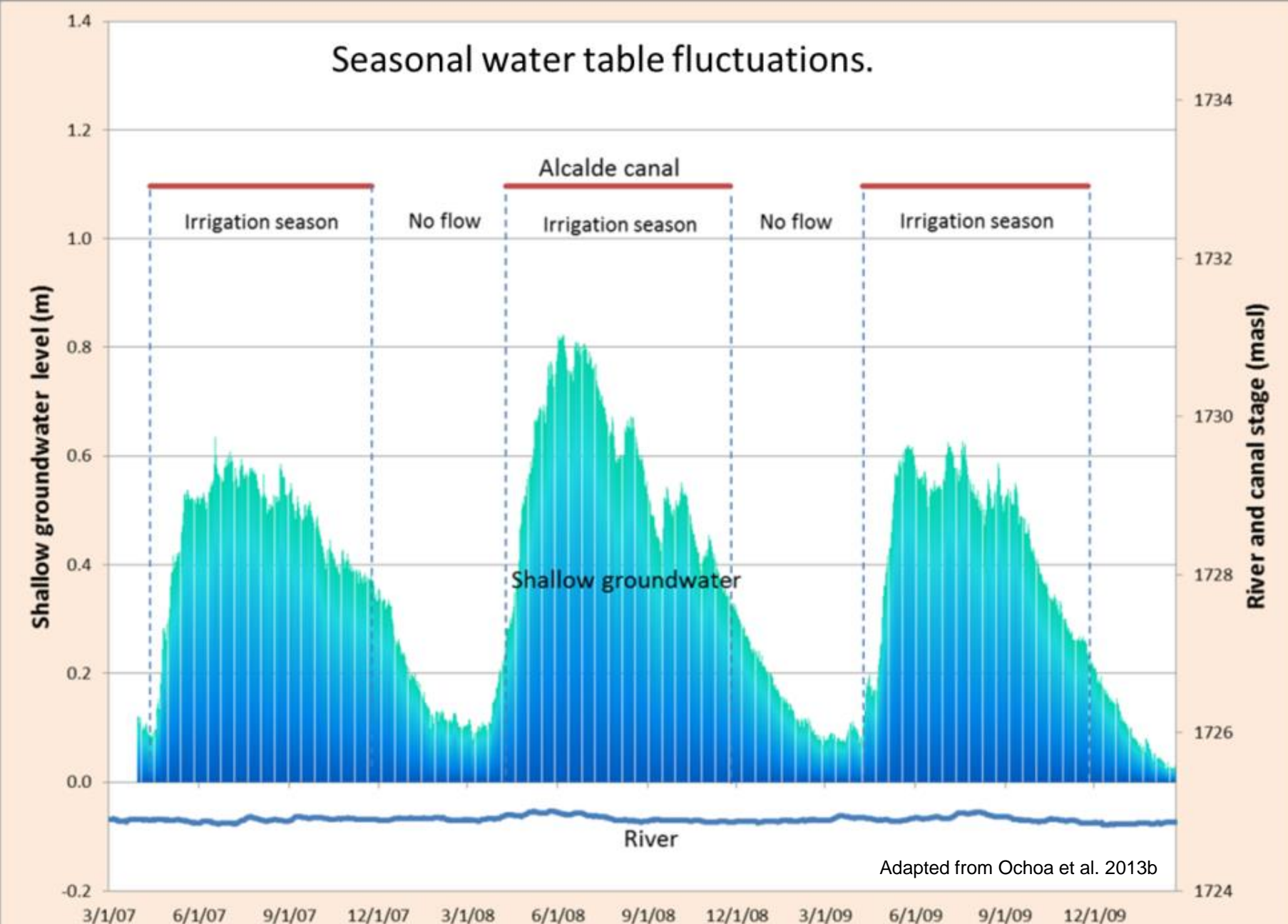
Meters

Surface water and groundwater connectivity – Watershed

Water table map created based on field measurements shows ground water flows westward towards the Rio Grande.

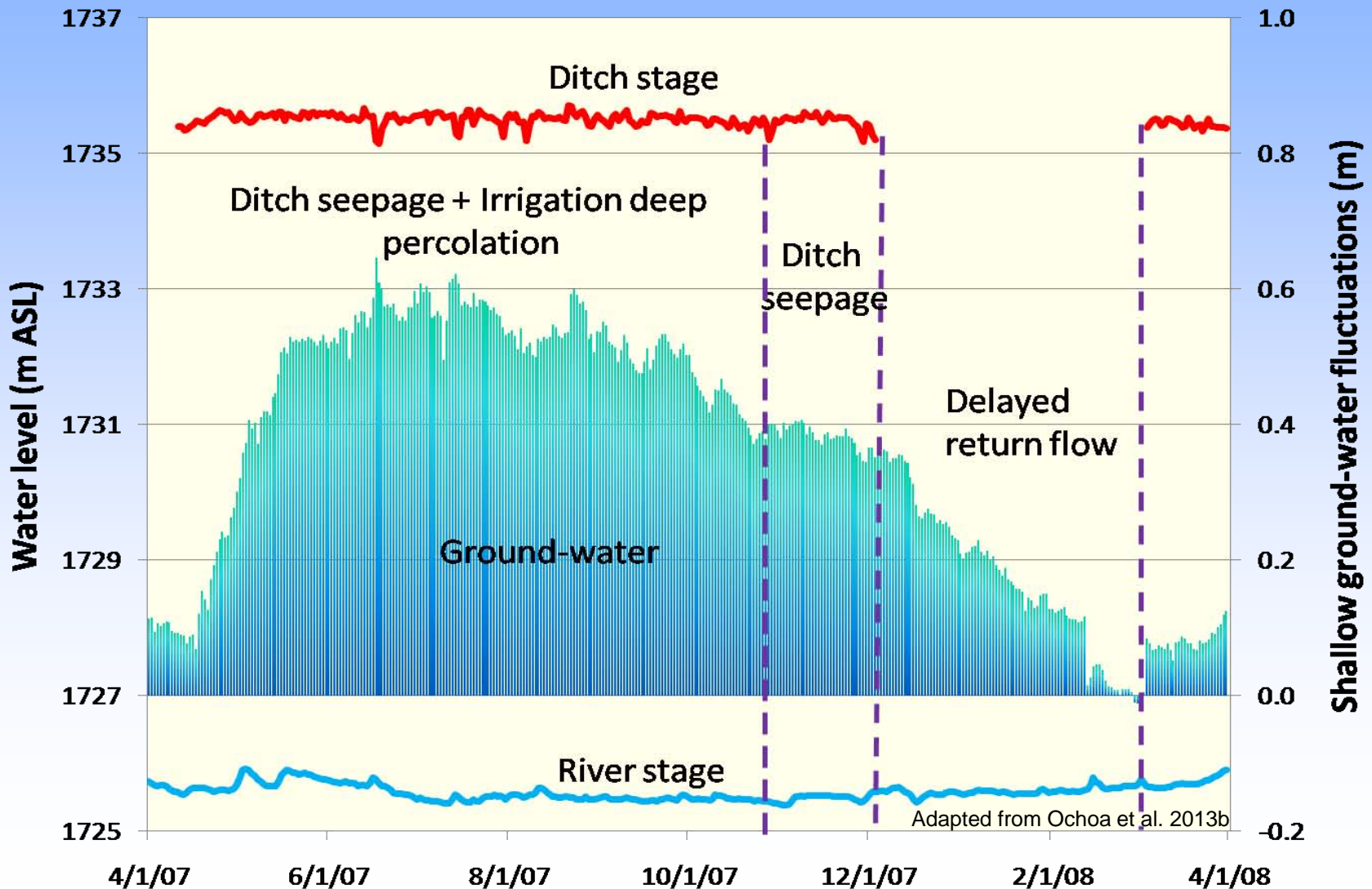


Surface water and groundwater connectivity - Valley



Aquifer response to ditch and irrigation inputs?

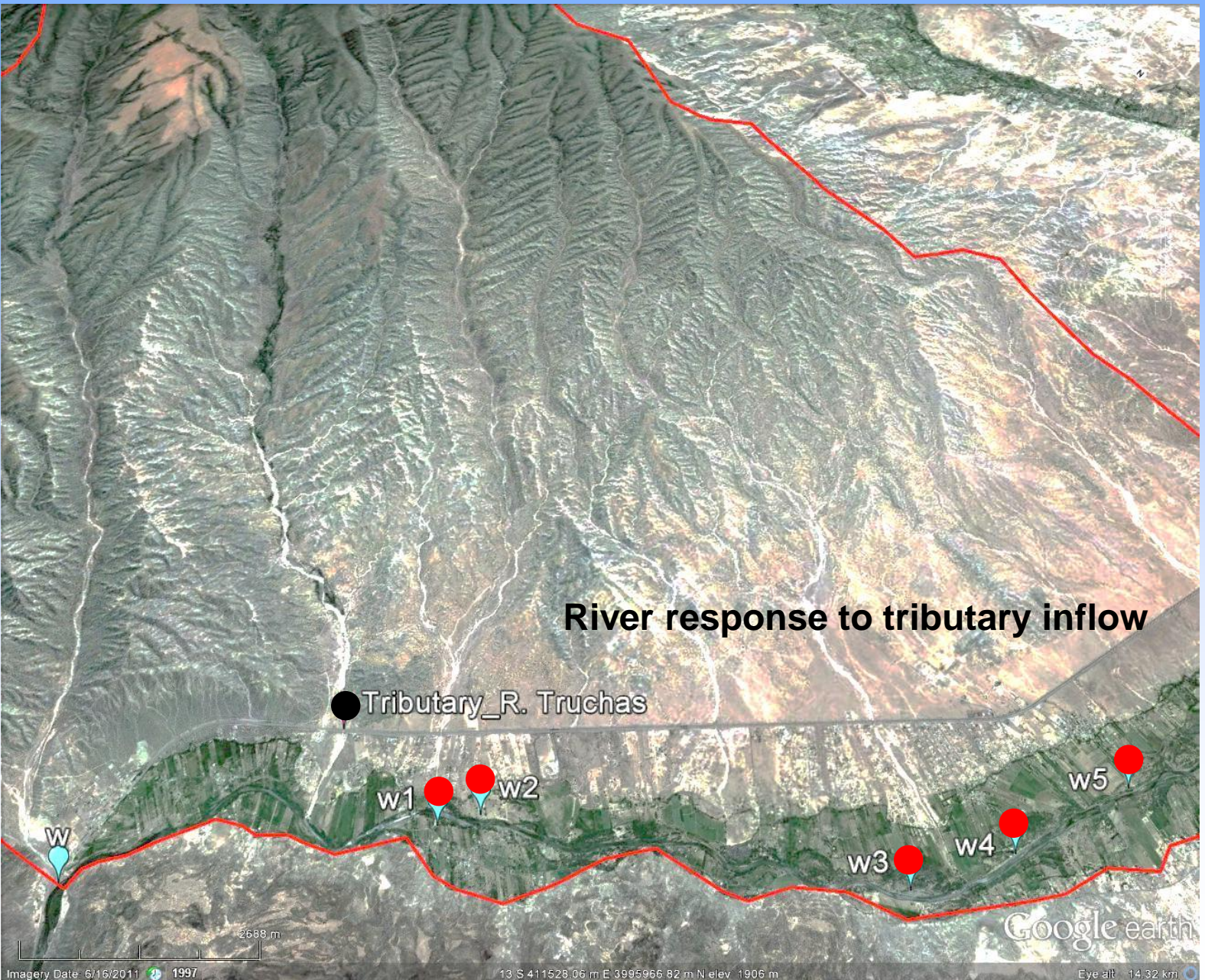
- A significant amount of delayed return flow is observed after the end of the ditch flow season.



Component	Amount from canal diversion + total precipitation (%)	Range (%)
Flow control diversion	9.5	0 to 14
Crop field runoff	8.9	0 to 19
Canal outflow	40.9	28 to 67
Canal seepage	12.1	5 to 17
Deep percolation	21.2	9 to 32
Crop evapotranspiration	7.4	1 to 15
Total	100.0	

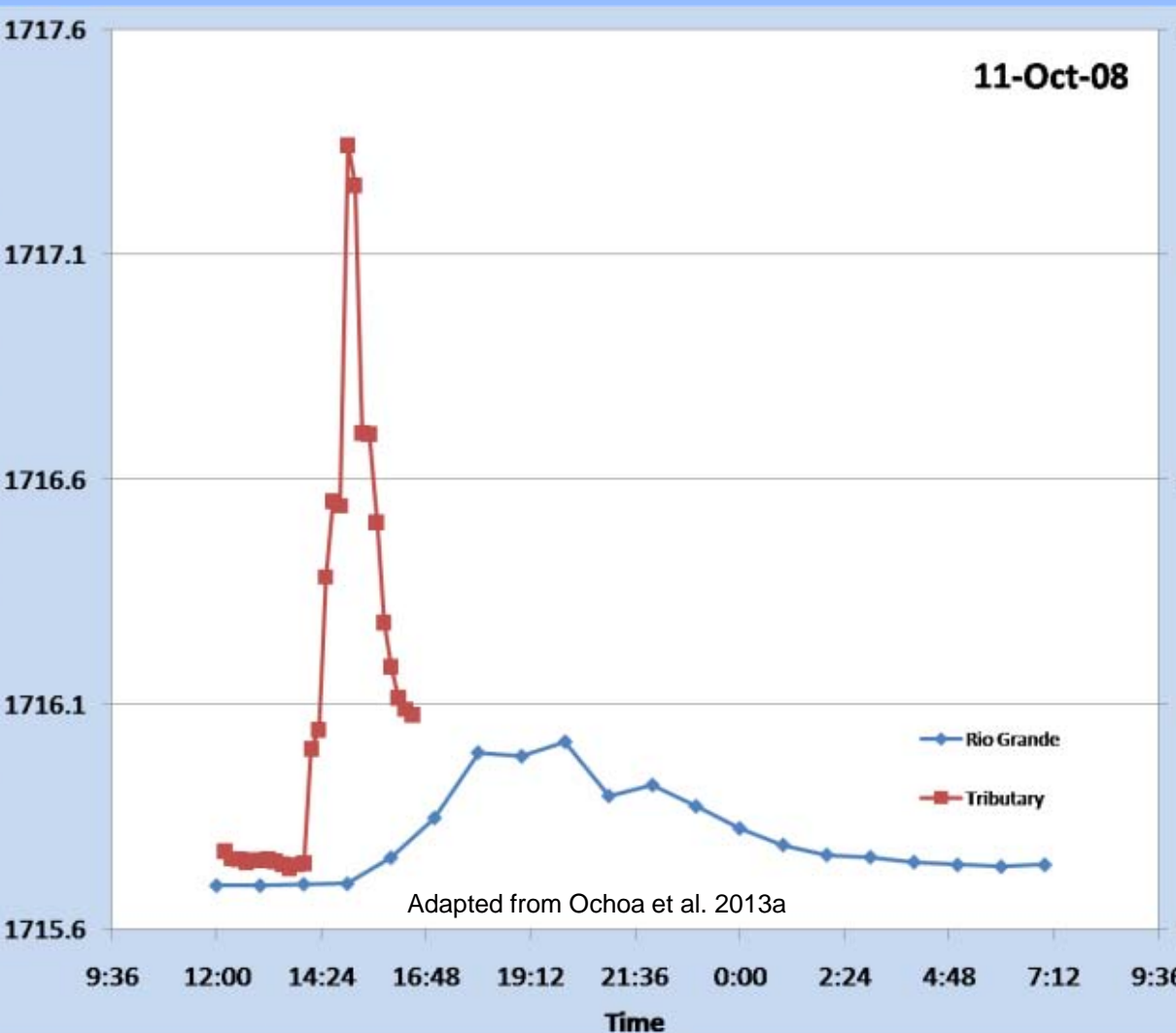
Table 1. Three-year (2005-2007) averaged water budget of the Alcalde main irrigation canal.

Head waters and floodplain valley - hydrologic connectivity



Head waters and floodplain valley - hydrologic connectivity

- River stage increased up to 0.3 m after a flashflood event with peak discharge of $17.9 \text{ m}^3 \text{ s}^{-1}$ at the tributary stage-measuring station.



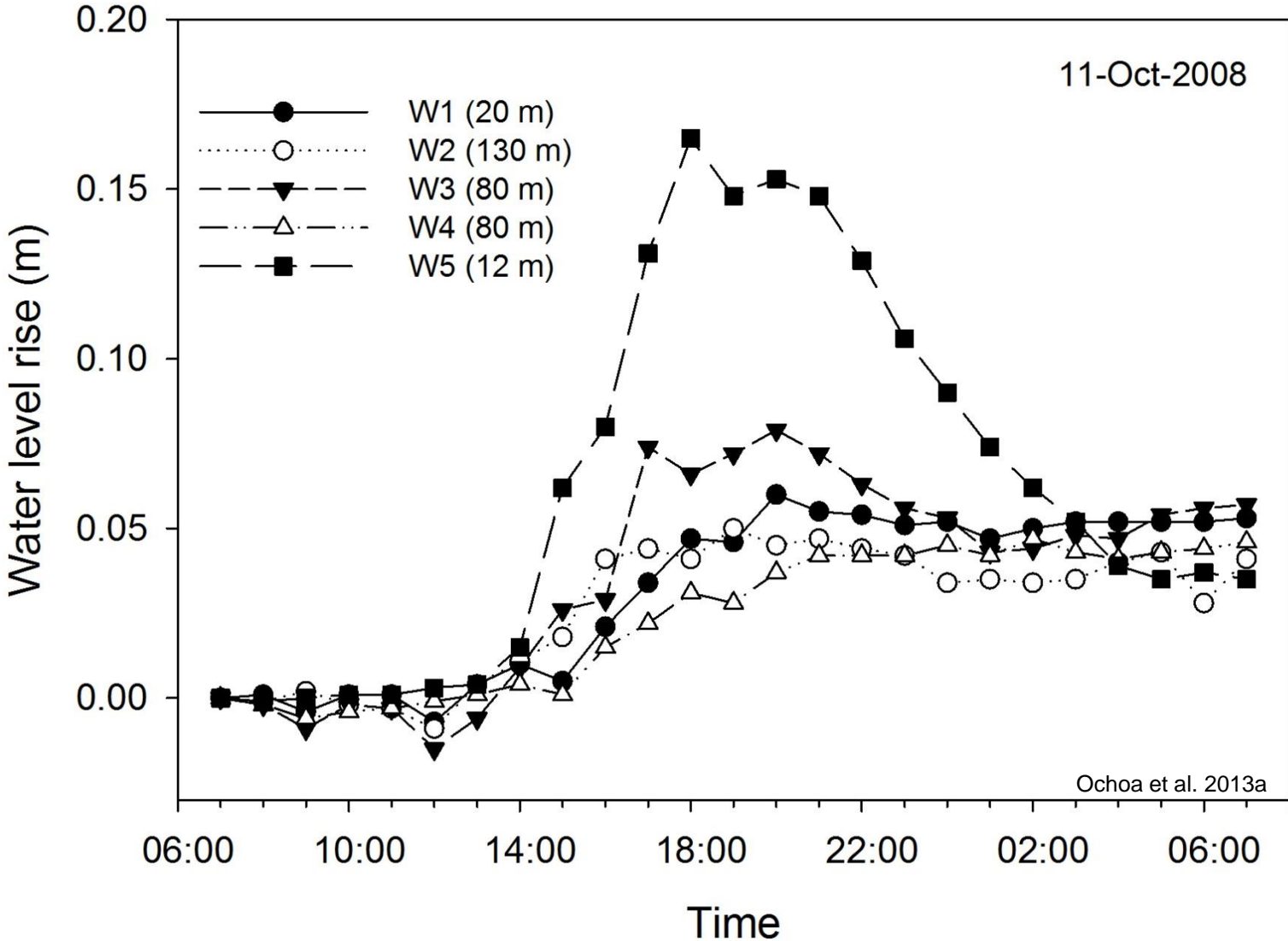
Tributary



Rio Grande

Head waters and floodplain valley - hydrologic connectivity

- Water levels in wells near the river increased in response to rainstorm inflow.



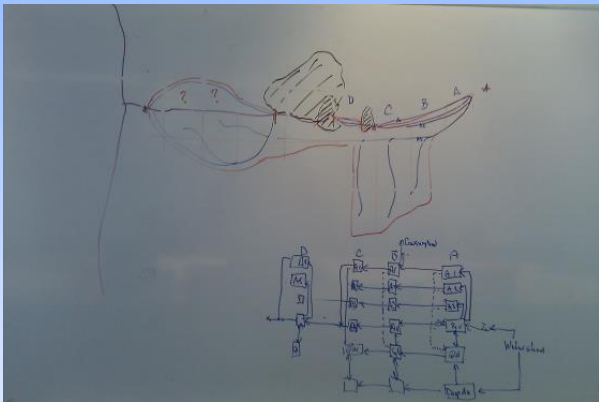
Ochoa et al. 2013a

Modeling hydrologic connectivity – System dynamics

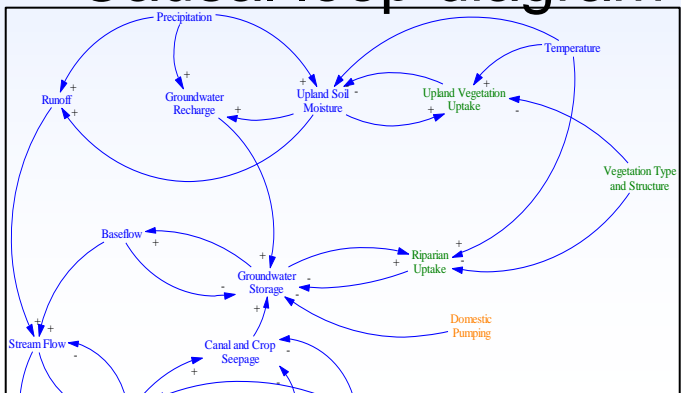
Concept



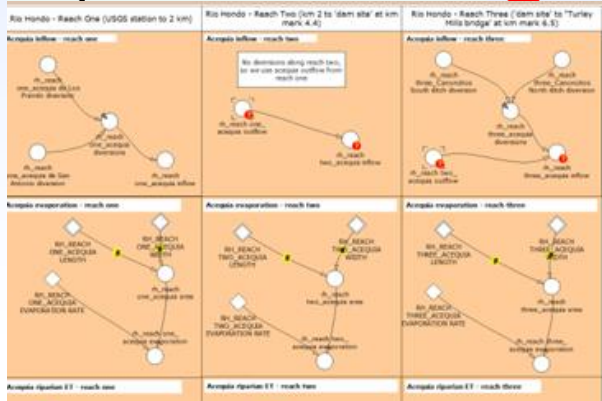
Feedback



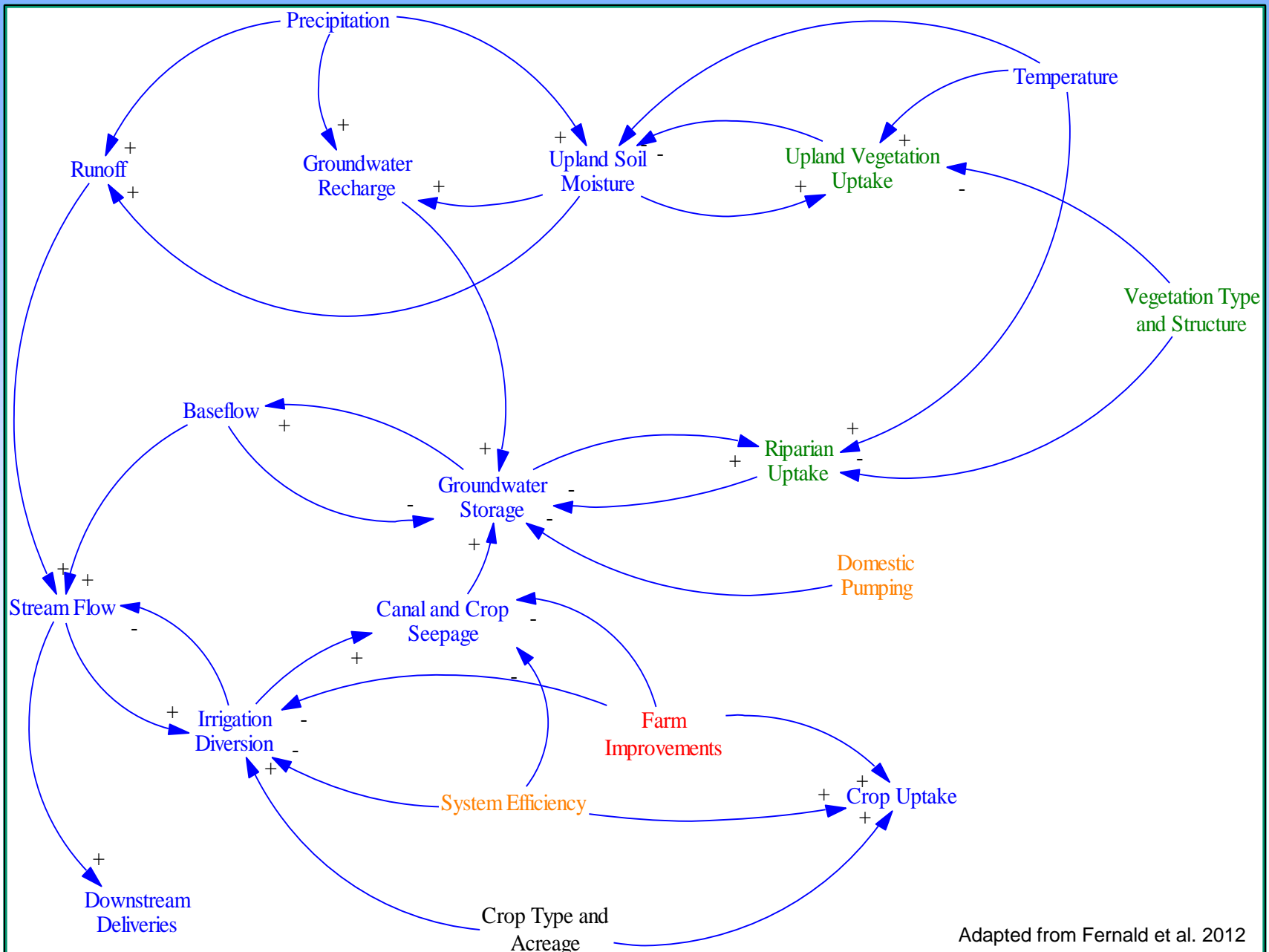
Causal loop diagram



Systems model



Hydrologic connectivity – cross disciplinary



Adapted from Fernald et al. 2012

Community participation

- Support from our collaborators has been critical for the success of the research activities.



Acequia parciantes, extension faculty, and researchers meeting in Santa Fe, NM.

Our thanks to our multiple collaborators:

Acequia parciantes, ranchers, well owners, acequia associations, and mutual domestic water associations in the communities of Alcalde, Velarde, Truchas, Valdez, Arroyo Hondo, and El Rito, NM.

Las Nueve Acequias en el Rio Grande

A. de Alcalde, A. de la Canova, A. Ancon, A. San Rafael del Guique, A. Madre del Bosque, A. de Los Chicos, A. Garcia, A. del Medio, A. Rinconada Isla.

Acequias of the Rio Hondo

La Cuchilla ditch, A. de Los Prando, A. de San Antonio, Canoncitos ditch north, Canonictos ditch south, A. de Atalaya, A. Madre del Llano, A. de La Plaza.

Acequias of El Rito

A. de la Otra Vanda, A. Madre, A. Alire. A, del Monte, A. del Jaral.

References:

Ochoa, C.G., S.J. Guldan, A. Cibils, S. Lopez, K. Boykin, V.C. Tidwell, A. G. Fernald. 2013. Journal of Contemporary Research and Education. Hydrologic connectivity of head waters and floodplains in a semiarid watershed. *In review*

Ochoa, C.G., A.G. Fernald, S.J. Guldan, and V.C. Tidwell. 2013. Shallow aquifer recharge from irrigation in a semi-arid agricultural valley in New Mexico. Journal of Hydrologic Engineering. *In press*

Fernald A., V. Tidwell, J. Rivera, S. Rodriguez, S. Guldan, C. Steele, C. Ochoa, B. Hurd, M. Ortiz, K. Boykin, and A. Cibils. 2012. Modeling sustainability of water, environment, livelihood, and culture in traditional irrigation communities and their linked watersheds. *Sustainability*, 4 (11):2998–3022.

Ochoa, C.G., A.G. Fernald, and S.J. Guldan. 2011. Caracterización del balance hídrico y la recarga por retorno de riego en un valle agrícola de una región semiárida de los Estados Unidos de América (Water balance characterization and aquifer recharge from irrigation in an agricultural valley of a semiarid region in the United States of America). *In* J. Martinez and N. Sanchez (Eds.) *Estudios en la Zona no Saturada del Suelo*, 10:337–340.

<http://www.waterconnections.org>