Ditch and Field Seepage Effects on Shallow Groundwater and River Flow

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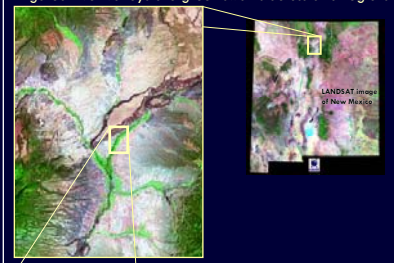
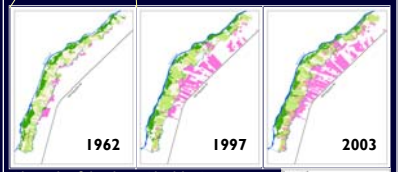
Background

Irrigated river valleys are green swaths across arid regions



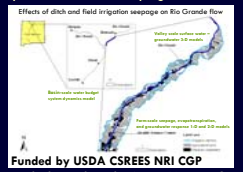


Along the 9 km-long Alcalde Acequia, land uses changed over 41 years from cash crops to pasture and from agricultural land to residential uses.

In northern New Mexico, traditional acequias are the main irrigation systems. Acequias typically flow all irrigation season and have high seepage rates from earthen beds and banks.

Ohkay Owingeh Acequia

Interest in lining irrigation ditches, land use changes, and water transfers out of local agriculture combine to make likely reduced seepage from acequia irrigation systems with potential loss of seepage benefits.



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This study based at the New Mexico State University Alcalde Science Center is designed to determine the effects of irrigation system seepage on valley water budgets and river flow.

Ditch seepage

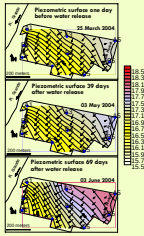
SEEPAGE FROM DITCH

- Impoundment tests
- Inflow-Outflow tests in November when no diversions
- 12% -16 % seepage over irrigated length of Alcalde Ditch

WELL TRANSECTS AT ALCALDE CENTER

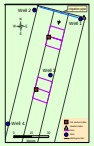
SHALLOW GROUNDWATER RESPONSE

- Without seepage, groundwater drops
- With ditch seepage, water table starts rising; water quality data confirm ditch water origin of added shallow groundwater
- With ditch seepage and field seepage, water table rises and flowpaths orient more towards river



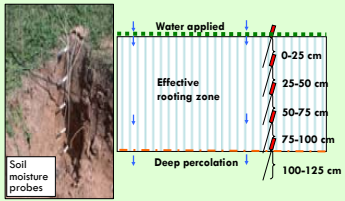
Field seepage

FLOOD IRRIGATION SEEPAGE

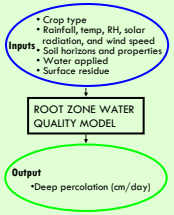


MEASURED DEEP PERCOLATION

TDR probe water balance method

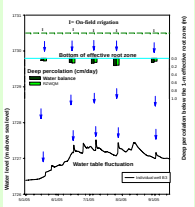


MODELED DEEP PERCOLATION



PERCOLATION AND GROUNDWATER RESPONSE

- Close match measured and modeled percolation
- 15-62% percolation depending on antecedent soil moisture and irrigation amount
- Flood irrigation percolates past root zone and reaches shallow groundwater

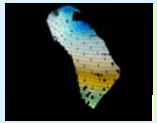


Water quality

WATER QUALITY SAMPLING

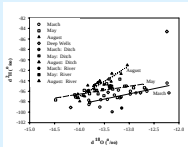
- Additional well transects
- Monthly samples
- Analyzed for all major ions

GAINING RIVER REACH



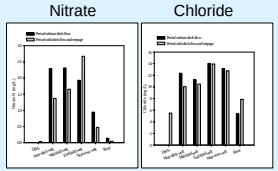
River stage always below floodplain water table

STABLE ISOTOPES



- Stable isotope results show no strong pattern of deep groundwater upwelling

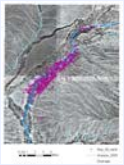
SEEPAGE DILUTES GROUNDWATER IONS



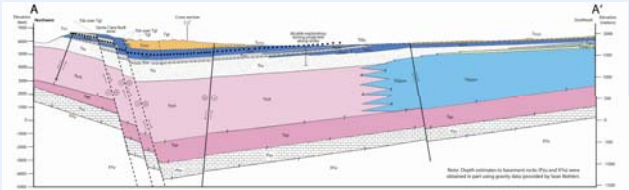
Groundwater

FORGOTTEN REACH

GEOPHYSICAL MODEL

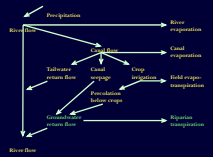


SHALLOW FLUVIAL GRAVELS IN RIVER FLOODPLAIN

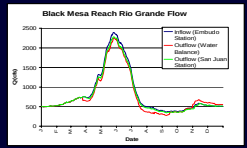


Integration

VALLEY-SCALE WATER BALANCE



Acequia system redistributes river flow from spring snowmelt through shallow groundwater return flow to fall river flow



ONGOING MODELING

1-D (RZWQM) crop percolation

- 2-D (Hydrus-2D) crop and ditch seepage to shallow groundwater

- 3-D (MODFLOW) seepage, groundwater flow, and return flow along Alcalde Ditch and larger valley

- System Dynamics (POWERSIM) incorporation of seepage and return flow into interactive Rio Grande Basin model

Conclusions

Acequia systems act as aquifer storage and recovery

Net reduction in losses to atmosphere from storage for 1-3 months underground

Return flow provides wet water downstream after peak runoff season

Modeling will integrate surface water and groundwater interactions to predict hydrologic effects of changing land and water use