

## **WATER DEPLETIONS FROM SOIL EVAPORATION**

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### **ABSTRACT**

Soil evaporation is a significant loss or depletion from the water balance. Most often, this water balance component is lumped together with plant transpiration into the collective term “evapotranspiration (ET).” However, because evaporation and transpiration are distinctly different phenomena, it is useful to consider evaporation explicitly and separately.

Soil evaporation is maximized if there is a shallow groundwater table, a hot and dry climate, bare surface exposed to sunlight and wind, and a uniform fine-grained soil. Perhaps the most important factor in the amount of soil evaporation is the proximity of the water table. If the water table is very shallow (within a meter or so), water will be continually supplied from the water table upward to the soil surface. This type of evaporation is often termed water table evaporation. In this case, soil evaporation will be controlled largely by climatic conditions at the soil surface. Steady-state evaporation rates from bare soil with a groundwater table at 1 or 2 m depth have been measured up to 1 to 8 mm/day range. This rate is on the order of those measured in the bosque in the presence of cottonwoods and salt cedars, and suggests that even if all phreatophytes were removed, soil evaporation may remain a considerable depletion.

In addition to evaporation in the presence of a shallow water table, a significant fraction of the water that infiltrates from precipitation or irrigation can evaporate. This type of evaporation has a rate that decreases with time. As the soil near the surface dries, the control on evaporation shifts from climatic conditions to the ability of the soil to transmit water upward to the ground surface for evaporation.

Of current interest in riparian areas is the effect restoration activities can have on water balances. Clearing and thinning of bosque vegetation will necessarily reduce the amount of shaded soil and increase the exposure of the soil to wind. Thus, the amount of soil evaporation may increase. Removal of surficial detritus and leaf litter may also affect soil evaporation. These materials form mulch, which can dramatically reduce the soil evaporation.

Soil evaporation is being measured at five sites in the Middle Rio Grande bosque using both soil water flux measurements and surface temperature measurements. The soil flux measurements involve measuring water content and potential at various depths within the soil and relating these values to soil water fluxes. Soil water fluxes, in turn, can be interpreted as evaporation rates. Surface temperature measurements utilize a simplified energy balance approach that is based on the fact that surface temperature depends on the amount of moisture in the soil. All other factors being equal, a wetter soil will have a lower temperature during the day compared to a drier soil because evaporation of soil water consumes some of the net radiation at the surface. This method requires the measurement of the surface temperature of a reference material, typically a completely dry soil. We are investigating extrapolating this method to a remote sensing (satellite) platform.

### **ACKNOWLEDGMENTS**

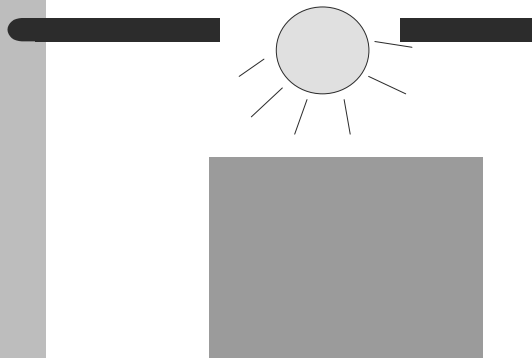
We are grateful for the support and assistance of the ESA Collaborative Program; Students: Enrique Farfan and Dylan Harpe; and the UNM ET Research Group.

## Water depletions from soil evaporation

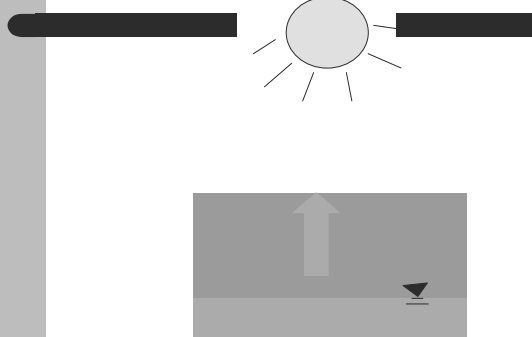
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April 21, 2004

### Transient evaporation



### Water table evaporation

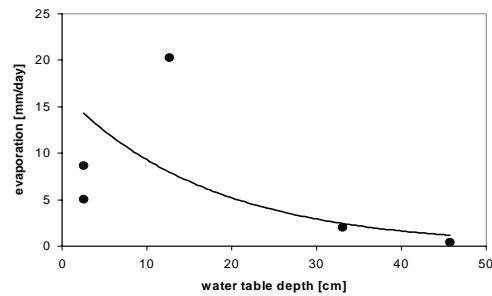


## How much soil evaporation is there?

- It depends on ..
- Depth to water table
  - Type of soil
  - Climatic conditions
  - Surface conditions

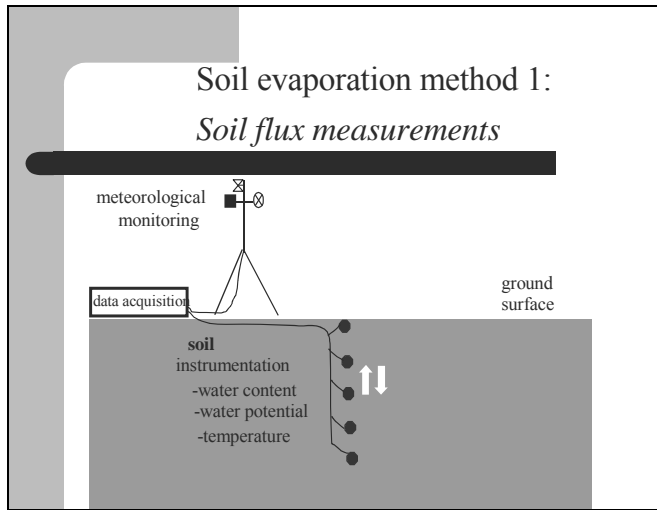
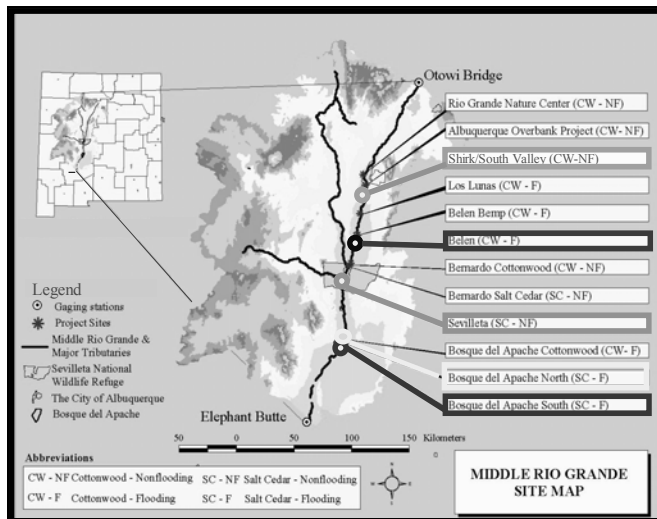
*Water table evaporation can be on the order of 5 to 10 mm per day.*

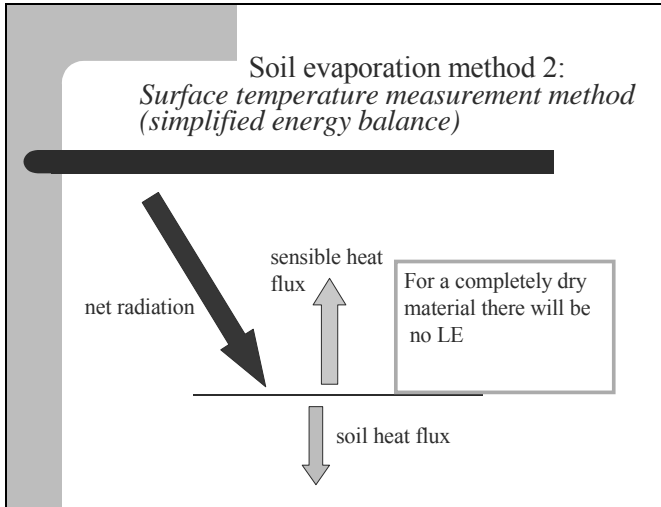
## Preliminary water table evaporation data



Bosque restoration activities will impact the amount of soil evaporation





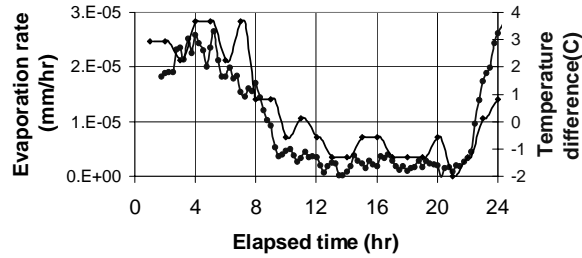


**LE can be estimated from surface temperature differences**

$$LE = \underbrace{\Delta R_n - \Delta G - \Delta H}$$

$\Delta R_n$ ,  $\Delta G$ , and  $\Delta H$  are all a function of  $\Delta T$ s of ambient soil and dry material

## Preliminary data



## Applications

- Small scale - hand held infrared thermometers



- Large scale - remote sensing



## Conclusions

- Soil evaporation with a shallow water table can be a significant depletion
- Restoration activities can impact amount of soil evaporation
- Soil evaporation is being measured in Middle Rio Grande near existing ET tower sites