

Returns as Residual?

ESHMC Meeting

31 March/ 1 April 2009

B. Contor

History

- ◆ On-farm Water Budget Discussion (last ESHMC meeting):

During the discussion (or maybe as a sidebar) Willem proposed that instead of using returns to calculate *PERCOLATION* as a Residual, we should use other methods to estimate percolation and calculate *RETURNS* as a residual.

I. Land-surface Water Budget

Conceptual Components

◆ Inputs to Land Surface

- Diversions
- Precipitation

◆ Outflows from Land Surface

- Percolation
 - Canal seepage
 - In-field percolation in surface-water-only parcels
 - Offset net extraction (net consumptive use) from ground-water on mixed-source parcels
- Returns to Surface Water
- ET to Atmosphere

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II. River-gains Water Budget Conceptual Components

◆ Inputs to River Reach

- Upstream Gage
- Return Flows
- Gains from Aquifer

◆ Outflows from River Reach

- Downstream Gage
- Diversions

II. River-gains Water Budget Conceptual Components

◆ Inputs to River Reach

- Upstream Gage
- Return Flows
- Gains from Aquifer

◆ Outflows from River Reach

- Downstream Gage
- Diversions

III. ESPAM1.1 Algorithm

◆ Percolation as Residual

- + ● Diversions
 - + ● Precipitation
 - ● Returns
 - ● ET
-

- = ● Percolation (residual)
 - Canal leakage
 - SW-only percolation
 - Offset net GW pumping on Mixed-Source

◆ Gains as Residual

- + ● Diversions
 - + ● Downstream Gage
 - ● Upstream Gage
 - ● Returns
-

- = ● Gains (residual)

III. ESPAM1.1 Algorithm

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◆ Gains as Residual

- + ● Diversions
 - + ● Downstream Gage
 - ● Upstream Gage
 - ● Returns
-

- = ● Gains (residual)

IV. Alternate Algorithm

◆ Direct estimation of Percolation

- + ● Canal leakage
 - + ● SW-only percolation
 - + ● Offset net GW pumping on Mixed-Source
-

= ● Percolation

◆ Use Percolation to Estimate Returns

- + ● Diversions
 - + ● Precipitation
 - ● Percolation
-

= ● Returns (residual) →



IV. Alternate Algorithm

◆ Use Estimated Returns to Calculate Gains

- + ● Diversions
- + ● Downstream Gage
- ● Upstream Gage
- ● Returns

= ● Gains (residual)

Pros & Cons of Alternate Method

◆ Pro

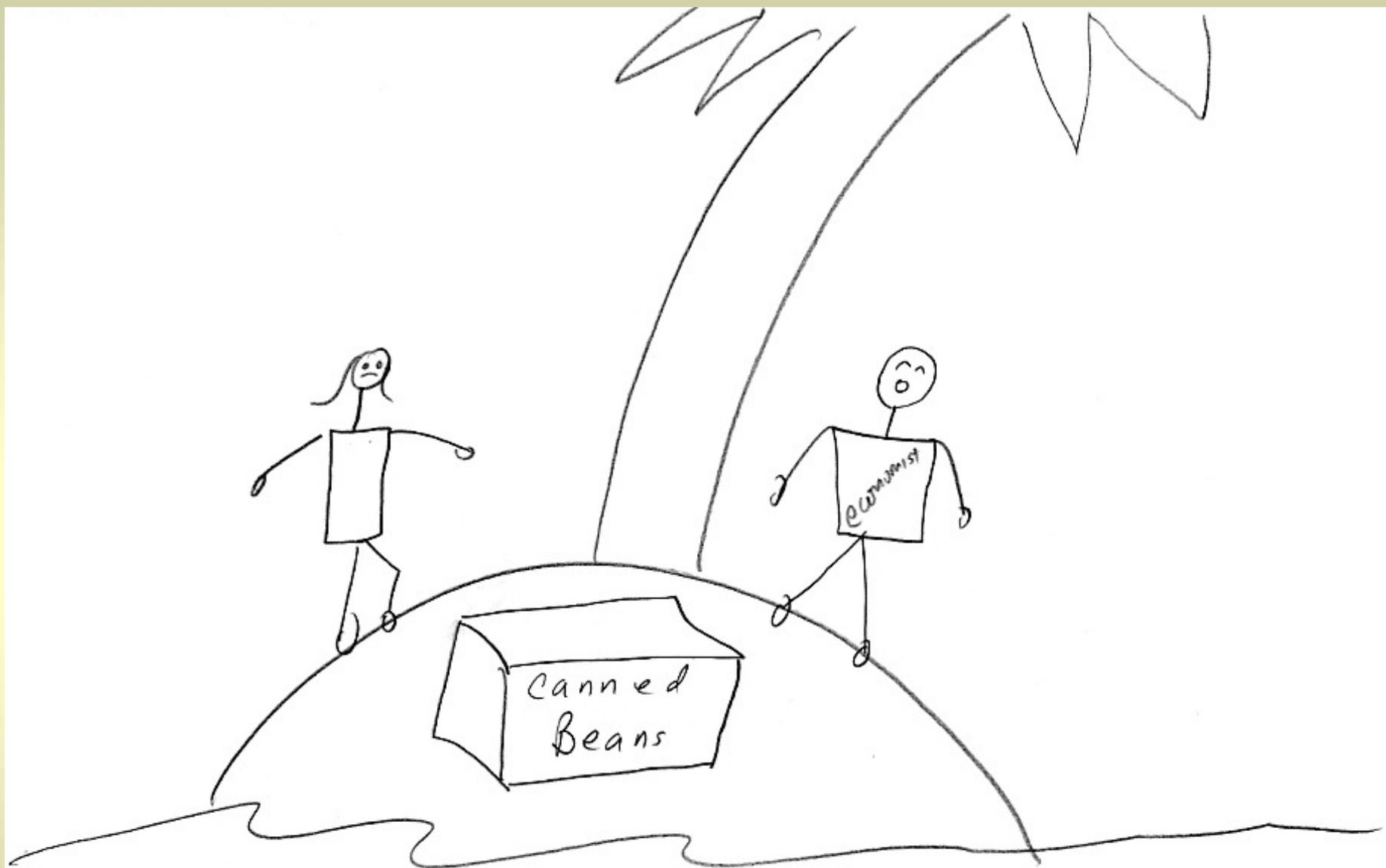
- No need to gather diversion data (diversions cancel)
- Insulates from uncertainty in diversions & returns

◆ Con

- Need to develop and vet methods
 - canal leakage
 - SW in-field perc.
 - Offset net GW on mixed-source
- Exposure to uncertainty in these methods
- Significant disruption to schedule & budget

Tentative Decision

- ◆ Alternate method has merit
- ◆ Should be considered in ESPAM 3
 - Improved returns data may reduce need?
- ◆ Continue w/ ESPAM2 as planned
 - Consider alternate in ESPAM2 uncertainty analysis?



"Why don't we just assume a can opener?"

Backup Slides

Diversions cancel

RIVER FLOW

+ Diversions	Data
+ Downstream Gage	Data
- Upstream Gage	Data
- Returns	(see below)
= <u>Gains</u>	

Returns:

+ Diversions	Data
+ Precipitation	Data
- ET	Data
- (canal seepage)	Est.
- (SW in-fld perc)	Est.
- (offset GW, Mx)	Est.
= <u>Returns</u>	

(change sign & substitute)

RIVER FLOW

+ Diversions	Data
+ Downstream Gage	Data
- Upstream Gage	Data
- Diversions	Data
- Precipitation	Data
+ ET	Data
+ (canal seepage)	Est.
+ (SW in-fld perc)	Est.
+ (offset GW, Mx)	Est.
= <u>Gains</u>	

(simplify: + Diversions - Diversions = zero)

RIVER FLOW

+ Downstream Gage	Data
- Upstream Gage	Data
- Precipitation	Data
+ ET	Data
+ (canal seepage)	Est.
+ (SW in-fld perc)	Est.
+ (offset GW, Mx)	Est.
= <u>Gains</u>	

Explanations (ESPAM1.1 algorithm)

- ◆ Returns are estimated from diversions:
$$\text{Returns} = \text{Divs} * \text{Return Fraction}$$
- ◆ Return Fractions were calculated from measured returns, or estimated from nearby similar entities
- ◆ "Offset GW, mixed" means a net gain to the aquifer due to reduced CU from GW pumping when SW is delivered to a mixed-source parcel

Partition of percolation

- ◆ Canal seepage is subtracted from divs. before calculating in-field percolation
 - net recharge doesn't change, only spatial location (in-canal vs. in-field)
- ◆ No matter what the assumed GW fraction on mixed-source lands, for all the mixed-source & SW lands, net recharge is:
$$\text{Divs} - \text{Cnl} - \text{Ret} + \text{Precip} - \text{ET}$$
 - net recharge is always the same, only spatial dist. changes w/ partition to mixed-source lands

Illustration that GW-fraction
Partition only changes spatial
distribution in ESPAM1.1
algorithm.

Hypothetical Facts

- ◆ 30 acres mixed-source, 10 acres SW-only
- ◆ Net SW diversions = 40 acre feet
- ◆ nominal ET = 80 acre feet = 2 feet depth
- ◆ Precip = 40 acre feet = 1 foot depth
- ◆ Limited knowledge of mixed-source lands
- ◆ No data on GW pumpage



Calculation algorithms

- ◆ Diversion depth =
$$(\text{Div Vol}) / (\text{SW Acres} + \text{Mixed} (1\text{-frac}))$$
- ◆ SW-only Recharge =
$$\text{Acres} * (\text{Div} + \text{Precip} - \text{ET})$$
- ◆ SW on mixed-source =
$$(\text{Acres} * (1\text{-frac})) * (\text{Div} + \text{Precip} - \text{ET})$$
- ◆ GW on mixed-source =
$$(\text{Acres} * \text{frac}) * (\text{Precip} - \text{ET})$$
- ◆ Implied Efficiency =
$$(\text{Precip} - \text{ET}) / (\text{Diversion Depth})$$

Assume 90% GW on mixed-source parcels

◆ SW depth = $(40 \text{ acre ft}) / (30 * 0.1 + 10)$
= 3.08 feet

◆ SW-only
 $10 (3.08 + 1 - 2) = 20.8$

◆ SW on mixed
 $30 (0.1) (3.08 + 1 - 2) = 6.2$

◆ GW on mixed
 $30 (0.9) (1-2) = -27$

◆ Implied efficiency
 $(2 - 1) / 3.08 = 32\%$

*Net
Recharge
Zero*

Assume 50% GW on mixed-source parcels

◆ SW depth = $(40 \text{ acre ft}) / (30 * 0.5 + 10)$
= 1.6 feet

◆ SW-only
 $10 (1.6 + 1 - 2) = 6$

◆ SW on mixed
 $30 (0.5) (1.6 + 1 - 2) = 9$

◆ GW on mixed
 $30 (0.5) (1-2) = -15$

◆ Implied efficiency
 $(2 - 1) / 1.6 = 63\%$

*Net
Recharge
Zero*

Assume 10% GW on mixed-source parcels

◆ SW depth = $(40 \text{ acre ft}) / (30 * 0.9 + 10)$
= 1.08 feet

◆ SW-only
 $10 (1.08 + 1 - 2) = 0.8$

◆ SW on mixed
 $30 (0.9) (1.08 + 1 - 2) = 2.2$

◆ GW on mixed
 $30 (0.1) (1-2) = -3$

◆ Implied efficiency
 $(2 - 1) / 1.08 = 93\%$

*Net
Recharge
Zero*

Implications

- ◆ Assignment of GW fraction does not affect water budget
 - spatial distribution *within the entity* is affected
 - precise knowledge of fraction is not needed
- ◆ Water budget depends on correct Diversions, Returns and ET