Dreher, Karl

From: The Wylies [wylie123@srv.net]

Sent: Wednesday, April 06, 2005 7:27 AM

To: Karl.Dreher@idwr.idaho.gov

Subject: water budget

Karl

Bryce and I got together last night and came up with this explanation to resolve the apparent differences between the RASA water budet and the ESPAM water budget.

Allan

MEMORANDUM

To: Allan Wylie, IDWR
Fr: Bryce Contor, IWRRI
Date: 5 April 2005

Re: Water Budget Reconciliation with Garabedian Report

Allan -

This is a response to your request this morning to reconcile differences between the ESPAM water budget and the USGS RASA water budget values (Garabedian 1992) in the following categories:

Category	RASA	ESPAM
1. Recharge incidental to surface-water irrigation	4.8 MAF	3.4 MAF
2. Tributary underflow	1.4 MAF	1.0 MAF
3. Precipitation	0.7 MAF	2.2 MAF
4. River Losses	0.7 MAF	0.9 MAF
5. Other stream and canal losses	0.4 MAF	(included)

I was not always able to tell from the RASA documentation exactly how the above values were obtained, but this is an attempt to explain the ESPAM data and methods and reconcile at least some of the differences. One general departure is that while there is considerable overlap, the two studies consider different model areas, encompassing different lands and intercepting different boundary conditions. Another departure is that the ESPAM data included wet and dry years within a 22 year span, while RASA used only 1980 data. When the ESPAM water-budget was balanced over a period of time when net change in aquifer storage was approximately zero, only modest adjustments (well within the confidence of the methods and data) were needed to make inflows equal outflows.

Other differences are discussed below.

1. Recharge incidental to surface-water irrigation.

   Both studies calculated recharge by subtracting ET from net diversions. In both cases, net diversions came from watermaster delivery records and estimates of return flows. The primary differences between the ESPAM calculation and RASA are the ET depths used.

   RASA used average ET depths from various studies, ranging from 1.0 to 1.6

feet per year. ESPAM data were based on reference ET calculated from NOAA weather data using the Kimberly-Penman equation, applied to NASS average crop mix, using Allen-Brockway crop coefficients. This method was confirmed by comparison to SEBAL/METRIC satellite ET measurements within the study area. The range of gross ET values was approximately 2.0 to 2.9 feet per year.

2. Tributary Underflow

The ESPAM estimates were derived from Garabedian's, with the following modifications:

Garabedian included lands south of the Snake River that were not included in ESPAM, and includes underflow from basins adjoining those lands. That underflow was not included in ESPAM because it is believed that the incised Snake River canyon would intercept any underflow from the south.

Where ESPAM boundaries were extended beyond Garabedian's, (Rexburg Bench, Oakley Fan, Big Lost River) the values were adjusted by subtracting from Garabedian's underflow the expected net recharge contribution of the intervening lands that were added to the study area.

A temporal pattern was imposed on the time series. This was normalized, so it has no effect on the average annual volume.

The ESPAM water budget was balanced using a least-squares procedure. This reduced tributary underflow by four percent.

I haven't repeated the analysis this morning, but previously I have compared the values used in ESPAM, tributary-by-tributary, and found them compatible with Garabedian's. Overall, however, ESPAM uses 1.0 MAF of tributary underflow vs. 1.4 MAF used by Garabedian.

3. Precipitation

Garabedian assigned recharge from precipitation by soil class and average precipitation depth, without regard to land use. ESPAM assumed that irrigated lands had sufficient soil depth to store virtually all winter precipitation in excess of winter ET, to contribute to crop needs. Therefore, precipitation on irrigated lands was applied in the irrigation calculations described above. The effect of this calculation is that precipitation on irrigated lands produces more benefit to the aquifer in ESPAM calculations than in Garabedian's calculations, tending to offset the higher ET rates used in ESPAM.

ESPAM's non-irrigated lands recharge from precipitation was based on a non-linear calculation applied to monthly precipitation depth. Separate parameters were assigned for each of the soil types used by Garabedian, and the parameters were calibrated to reproduce Garabedian's net recharge when applied to Garabedian's average precipitation. ESPAM non-irrigated lands calculations also include estimates of net extraction by cities, and evapotranspiration from wetlands hydraulically connected to the aquifer. These are relatively minor components of non-irrigated recharge.

Because the calculation was applied to a time series of precipitation that included dry years, applied only to non-irrigated lands, and includes some minor aquifer extractions, the average ESPAM recharge from precipitation on non-irrigated lands was 0.5 MAF, versus 0.7 MAF in Garabedian's model. The total partition of precipitation in the ESPAM water budget is given below:

Precip on GW-irrigated lands	0.9 MAF
Precip on SW-irrigated lands	0.8 MAF
Recharge from Precip on Non-irr	0.5 MAF[1]
Total	2.2 MAF

4. River Seepage and Canal Leakage

The calculation of 3.4 MAF incidental recharge appears to include the canal leakage used in the ESPAM modeling effort. River seepage in the ESPAM model is as follows:

Snake River seepage above Shelley	285 KAF
Snake River seepage below Shelley	360 KAF
Seepage from non-Snake tribs	270 KAF
Total	0.9 MAF

Garabedian divided this into two categories, "River Losses" and "Other stream and canal losses." The RASA values for these two components sum to 1.1 MAF. This is slightly larger that the ESPAM value, consistent with the fact that ESPAM canal losses were included in the Incidental Recharge calculation.

[1] Total precipitation on non-irrigated lands is 5.1 MAF, of which 0.5 MAF is applied as recharge.