MEMO

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Date: June 16, 2010

To: Rick Raymondi

From: Mike McVay (MM)

cc: Sean Vincent, Allan Wylie, Willem Schreuder, Bryce Contor, Rick Allen

Subject: Evaluation of process for estimating Recharge on Non-irrigated Lands

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Introduction

Per your request, I have completed my evaluation of the Recharge on Non-irrigated Lands (NIR) process. The Eastern Snake Hydrologic Modeling Committee (ESHMC) has previously determined that our process for estimating recharge on non-irrigated land is to use ET Idaho data to calculate the amount of recharge based on precipitation, root zone moisture and soil type. Semi-log kriging is then utilized to interpolate the recharge data across the model domain.

The purpose of this evaluation is to:

1. Use the ET Idaho precipitation and soil moisture data from 45 weather stations to calculate recharge for each month for the period May 1980 – October 2008.
2. Use semi-log Kriging to interpolate the calculated recharge to each active cell in ESPAM 2.
3. Compare my results with Dr. Willem Schreuder's estimates to determine if his method is acceptable.

Interpolation

Due to software limitations, I am unable to evaluate all monthly recharge interpolations in a timely manner; therefore, I have randomly chosen 30 month/soil-type combinations to compare with Dr. Scheuder's calculations. Based on the 30 comparisons, the Kriged recharge estimates made by Dr. Schreuder and myself are very similar; with an average difference of 0.55% in the sum of all active model cells. Table 1 illustrates the differences in Kriged recharge results.

Table 1. Comparison of Kriged recharge.

Stress Period/Soil Type	McVay Sum (ft/month)[1]	Schruder Sum (ft/month)[1]	Diff (%McVay Sum)	Abs Diff (ratioMcVay Sum)
Dec 2001 Lava	1455.88	1455.67	0.01%	0.0001
Nov 1984 Thin	1149.73	1150.38	-0.06%	0.0006
Dec 1998 Thin	459.68	459.99	-0.07%	0.0007
May 1980 Thin	1639.82	1638.59	0.08%	0.0008
Jan 1982 Lava	781.20	780.42	0.10%	0.0010
Dec 2004 Lava	2158.85	2156.18	0.12%	0.0012
May 1993 Lava	1271.83	1269.69	0.17%	0.0017
Sep 1993 Thick	49.54	49.62	-0.17%	0.0017
Sep 1997 Thin	183.48	183.80	-0.17%	0.0017
Aug 1999 Thin	76.12	76.26	-0.18%	0.0018
Sep 1994 Thick	27.85	27.79	0.21%	0.0021
Aug 1989 Thick	38.84	38.76	0.22%	0.0022
Jun 2003 Thin	22.65	22.74	-0.36%	0.0036
Feb 1990 Lava	311.58	310.33	0.40%	0.0040
Oct 2002 Thick	65.36	65.10	0.40%	0.0040
Sep 1994 Lava	423.14	421.31	0.43%	0.0043
Jul 1995 Thick	43.48	43.29	0.44%	0.0044
Oct 2008 Lava	443.84	441.60	0.51%	0.0051
Apr 1982 Thin	381.65	379.33	0.61%	0.0061
May 2008 Lava	486.53	483.35	0.65%	0.0065
Apr 1994 Lava	465.45	462.40	0.66%	0.0066
Jan 1995 Thick	74.22	73.73	0.66%	0.0066
Oct 1984 Thick	166.46	165.25	0.73%	0.0073
Mar 1988 Thick	67.78	67.09	1.02%	0.0102
Oct 1999 Lava	60.54	59.89	1.09%	0.0109
Jun 1986 Lava	335.28	339.81	-1.35%	0.0135
Mar 1997 Thick	69.00	67.98	1.47%	0.0147
Dec 1995 Thick	85.58	84.09	1.74%	0.0174
Jan 1992 Thin	34.79	34.10	1.97%	0.0197
			Abs Avg	0.55%

[1]Values are the sum of all active cells in ESPAM 2. Values do not represent volume of water recharged.

Recharge Proxy Calculation

The ESHMC agreed that recharge is to be estimated using precipitation and soil moisture data from ET Idaho, and our proxy for recharge is calculated as follows:

$$Recharge = P - P\_rz$$

where:

Recharge is recharge to the aquifer
P is gross precipitation
P_rz is precipitation residing in the root zone

According to Allen and Robinson (2007), "P_rz is the amount of gross reported precipitation that infiltrates into the soil (i.e., less any runoff) and that remains in the root zone for consumption by evaporation or transpiration."

This proxy must be adjusted to estimate recharge for different soil types. We are using the Sage Brush and Dormant Turf covers in ET Idaho to represent the three general soil types of Thick Soil, Thin Soil and Lava Rock. The proxies we use to represent recharge on the various soil types are:

1. Recharge = P – $P\_rz_{\text{Sage Brush}}$ to represent Thick Soil.
2. Recharge = P – $P\_rz_{\text{Dormant Turf}}$ to represent Thin Soil.
3. Recharge = P – $2/3P\_rz_{\text{Dormant Turf}}$ to represent Lava Rock.

As a result of my evaluation process, it appears that Dr. Schreuder and I are calculating recharge at the 45 weather stations using the same methodology.

Issues with Proxy Calculation

During calculation of recharge, three situations were identified that confound our process for estimating recharge. I recommend that the following situations should be addressed by Dr. Rick Allen to ensure we are utilizing the ET Idaho data correctly in our recharge estimates:

1. Precipitation residing in root zone is negative.
   i. Typically occurs during dry periods.
   ii. P – (-Prz) results in unreasonably large amount of recharge.

The work-around we are employing for this situation is to consider this to be a soil moisture "deficit" and consider recharge to be zero.

2. Precipitation residing in root zone is greater than gross precipitation.
   i. Typically occurs during non-summer months (one in July) – only 15 occurrences.

ii. Difference is always 0.01 mm/day.
iii. P – Prz results in *negative* recharge value.

The work-around we are employing for this situation is to compute recharge as the absolute difference.

3. Dormant Turf root zone moisture is greater than Sage Brush root zone moisture.
   i. P – P_rz results in more recharge occurring on Thick Soil than on Thin Soil.
   ii. Previous work has demonstrated that recharge from precipitation is partly a function of soil texture and depth, and the general relationships between the soil types represented on the ESPA are that recharge from Lava > Thin Soil > Thick Soil (Contor, 2004; Garabedian, 1992).

No work-around has been employed. Although the resulting recharge is in conflict with our theory of NIR, it is not known why this situation occurs, or if it is in conflict with reality.

Some temporary solutions to the above calculation issues have been employed to move the interpolation process forward. However, I recommend that formal solutions should be pursued by the committee once Dr. Allen has had a chance to evaluate the data.

Conclusion

My evaluation concludes that Dr. Schreuder and I are calculating recharge using the same methodology. I further conclude that our interpolation efforts are very similar, and I have no issue with how he is Kriging the recharge estimates.

There are three issues with the ET Idaho data and our proxy for recharge. It seems most appropriate for Dr. Allen to investigate these issues and advise the committee on how to move forward.

References

Allen, R.G. and Robinson, C.W., 2007. Evapotranspiration and consumptive irrigation water requirements for Idaho. Kimberly Research and Extension Center, University of Idaho, Moscow, ID.

Contor, B.A., 2004. Recharge on non-irrigated lands. Idaho Water Resources Research Institute, University of Idaho, Moscow, ID. IWRRI Technical Report 04-006. Eastern Snake Plain Aquifer Model Enhancement Project Scenario Document DDW-003.

Garabedian, S.P., 1992. Hydrology and digital simulation of the regional aquifer system, Eastern Snake River Plain, Idaho. USGS.