MEMORANDUM

To: ESHMC
Fr: B. Contor
Date: 28 January 2008

Re: Groundwater Supply on Mixed-source Lands

Introduction

Based on the discussion of source of water on mixed-source lands at the 8 January 2008 ESHMC meeting, IWRRI agreed to consider:

1. How does the fraction of mixed-source lands in each entity from the ESPAM1.1 data set (derived from analysis of surface-water diversion volume) compare to the fraction implied by the 400-meter radius search discussed at the meeting?
2. What do the mixed-source maps look like if the radius search is modified so that only parcels nearest wells are deemed "Ground-water" and only parcels furthest from wells are deemed "Surface-water?"

The primary concern with the ESPAM1.1 method is that it uniformly distributed recharge from surface-water irrigation and discharge for ground-water irrigation across the mixed lands represented in each entity. It might be possible that near the river, for instance, this would affect simulated gains in the river and therefore the ability to match targets in calibration.

The primary concern with the method shown at the ESHMC meeting was that individual mixed-source parcels were assigned to be either ground-water-only or surface-water-only, but the field sample data indicated that for any individual parcel, the chance of error was approximately 30%. It could be expected that at some point, an individual would identify a particular parcel for which he/she had personal knowledge and our representation would be incorrect.

After further exploration, there are now six candidate methods to consider:

1. The method used in ESPAM1.1. Mixed-source lands were identified as all lands that had both surface-water and ground-water irrigation rights. The fraction of supply from ground water was based on analysis of surface-water diversion volumes but constrained to fall in the range 0.30 - 0.95.
2. The "Proximity" method illustrated at the ESHMC meeting. Mixed source lands within 400 meters of an irrigation well from the water-rights database were deemed to be ground-water supplied and all others were deemed to be surface-water supplied.

3. A "Dual Radius" method suggested in the ESHMC meeting. This has been represented here with all mixed-source parcels within 100 meters of an irrigation well deemed to be ground-water supplied, all parcels further than 1000 meters from an irrigation well deemed to be surface-water supplied, and all other parcels listed as "mixed-source undetermined." The fraction on "mixed-source undetermined" parcels was set at 50%, consistent with field inspection.
4. "Dual 2," a modified dual radius method where all parcels within 100 meters of a well are assigned 90% source fraction, parcels further than 1000 meters are assigned a 10% fraction, and other mixed-source parcels are assigned 50%.
5. A "Variable Radius" method where the ground-water fraction of parcels within 100 meters of a well was set at 80%, the fraction of parcels greater than 900 meters but within 1000 meters was set at 20%, and parcels greater that 1000 meters were set at 10%. Between 100 meters and 900, the fraction was linearly interpolated between 80% and 20% at 100-meter increments.
6. A "No Company" method, where IDWR water-rights, claims and recommendations ground-water irrigation polygons are sorted by owner name. Those polygons whose owner names appear to be canal companies or irrigation districts, or whose attribute "large place of use" is flagged, are set with ground-water fraction zero. Other polygons (that is, those whose owners are private entities) are set with ground-water fraction one.

The ESHMC is also interested in how any proposed new method compares with the ESPAM1.1 method in spatial distribution and overall representation of ground-water supply to mixed-source lands. It is important to remember, however, that there is no particular reason to believe the ESPAM1.1 method is correct, even though it represented our best effort at the time.

<u>This exploration</u>

This exploration has two parts; a test is made of the potential for distorting simulated reach gains using the ESPAM1.1 method, and the various methods are compared.

<u>The potential for distorting reach gains</u> was explored using the water-rights transfer tool, which is based upon ESPAM1.1. In the ESHMC meeting, we identified the lands around Springfield, Idaho as the most likely in the entire model to cause distortion. The ESPAM1.1 representation has a large block of mixed-source lands, but the proximity representation puts the surface-water lands on the west edge of the block and the ground-water lands between the surface-water lands and the river. Figure 1 shows the ESPAM1.1 representation of these lands, and Figure 2 shows the Proximity Method representation. Figure

3 shows lands in this area that ESPAM1.1 would have indicated as mixed but the Proximity Method indicates as ground-water supplied.

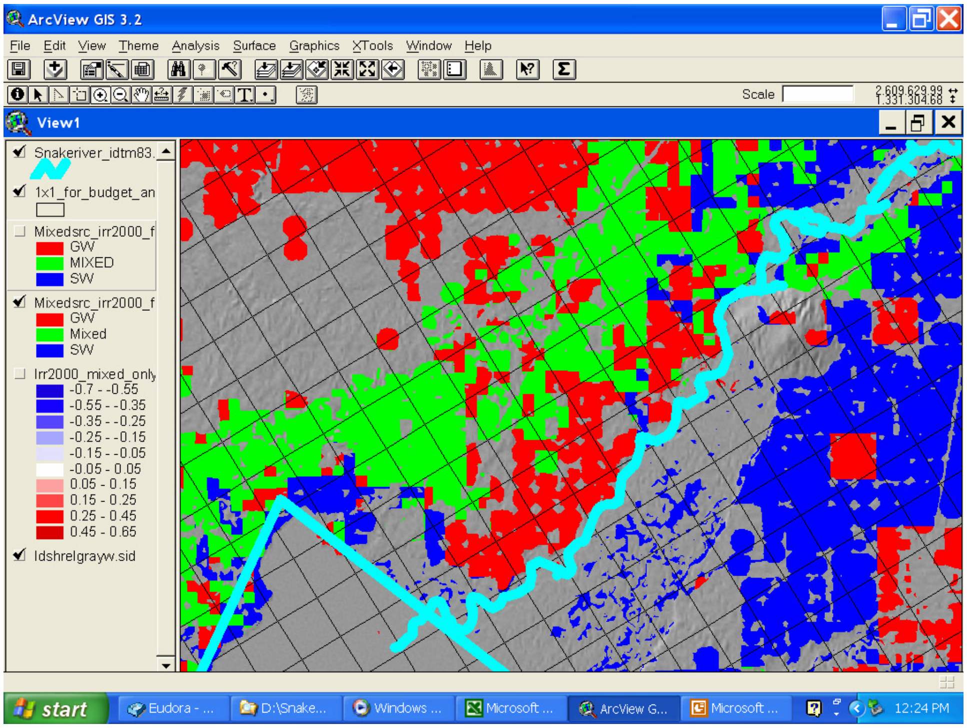

Figure 1. ESPAM1.1 indication of mixed-source lands near Springfield, Idaho.

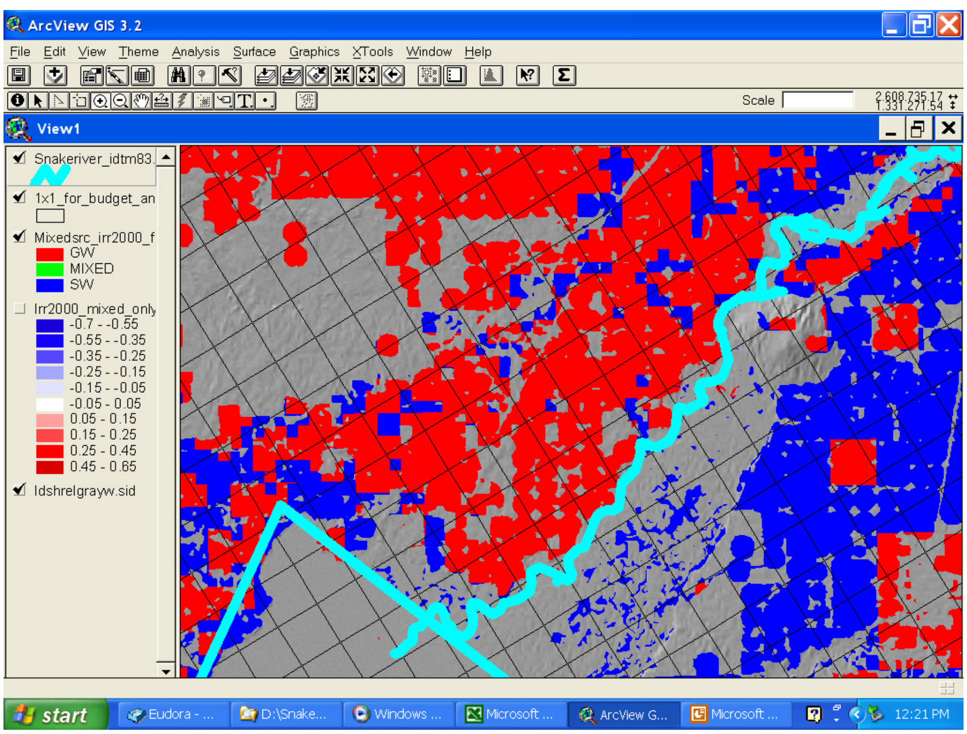

Figure 2. Proximity Method indication of irrigation water source on lands near Springfield, Idaho.

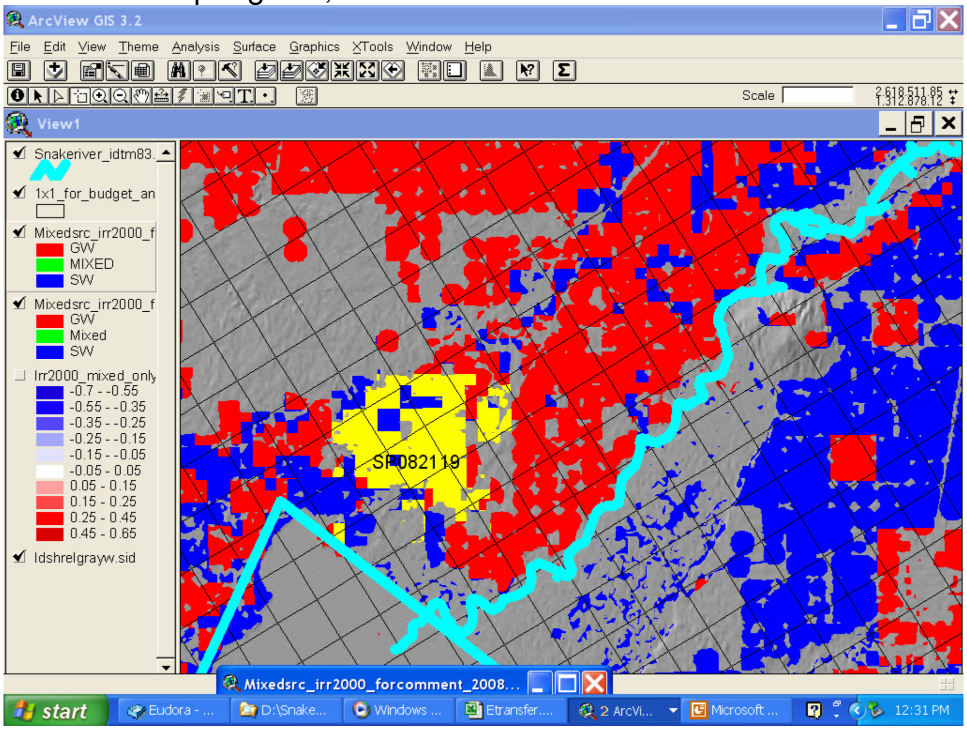

Figure 3. The yellow-colored lands are lands that ESPAM1.1 treats uniformly as mixed-source lands, but that the Proximity method indicates are likely to be physically supplied only from ground-water. The model cell with label "SP082119" is the cell at Row 82, Column 119 used in the transfer tool.

The ESPAM1.1 representation of these lands is that 70% of the supply is deemed to be from ground water and 30% is from surface water. There is uncertainty in the Proximity method, and ESPAM1.1 does already impute some ground-water pumping on these lands. Considering these facts, a rough estimate was made that for the lands shown in yellow in Figure 3, ESPAM1.1 under-represents the net of extraction and recharge by two feet (assuming pumping dominates), *in this area*. Note that this is only a distortion in spatial distribution; any actual under-representation is offset 100% by over-representation in some other area, so that the water budget for the irrigation entity (and the model as a whole) are unaffected.

The yellow lands sum to 4,257 acres. The equivalent stress of two feet per year on these lands was applied in the transfer tool as an extraction at Row 82 Column 119, the approximate centroid of the selected lands. This stress was applied to every summer trimester for 150 years. The indicated change in flux from the aquifer to the Near Blackfoot to Neeley reach of the river is about 12 cubic feet per second (cfs) in the summer, seven cfs in the winter and five cfs in the spring. This over-estimates the actual distortion, because the offsetting reductions that would occur somewhere else within the irrigation entity were not represented. Relative to total gains in the reach, and uncertainties in the target data, this is a small distortion.

<u>The comparison of methods</u> is in three parts. First, maps of the distribution of the fraction of supply deemed to be from ground water are compared. Second, the spatial distribution of ground-water-imputed lands is compared by region. Finally, cross-plots comparing the new methods with the ESPAM1.1 method are shown.

Figures 4 through 8 show the spatial distribution of the ground-water fraction on mixed-source lands by the various methods.

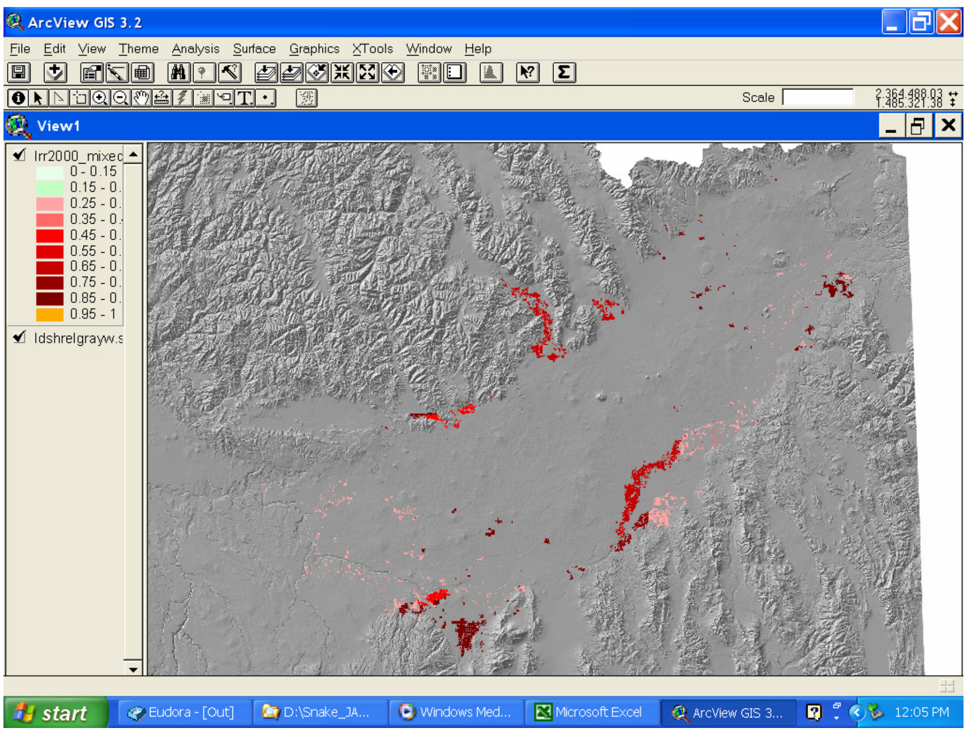

Figure 4. Ground-water fraction on mixed source lands using ESPAM1.1 representation.

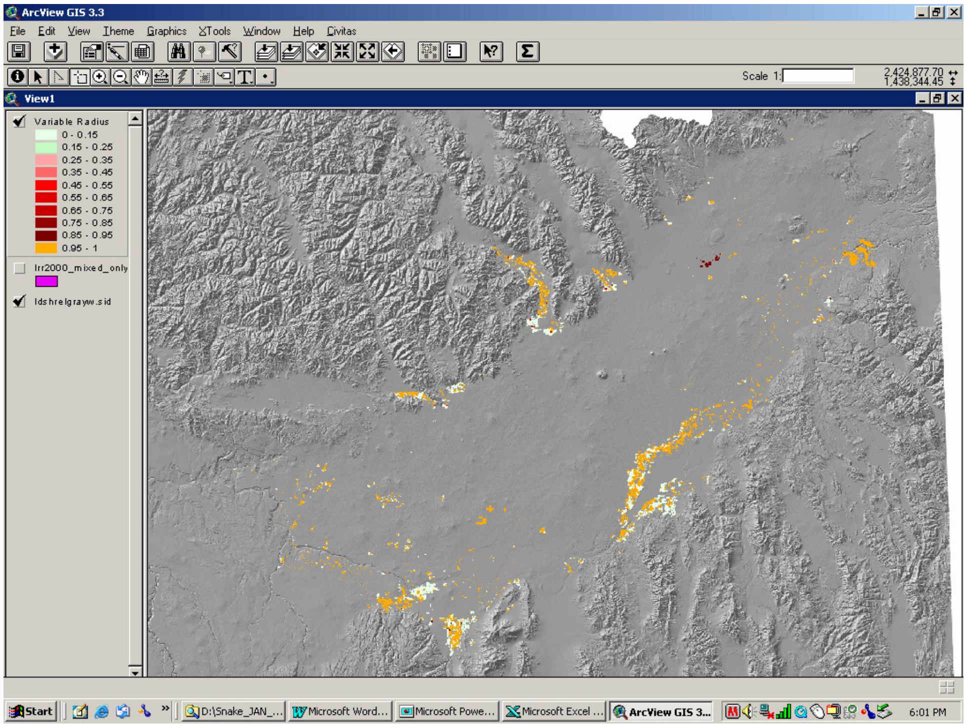

Figure 5. Ground-water fraction from Proximity method.

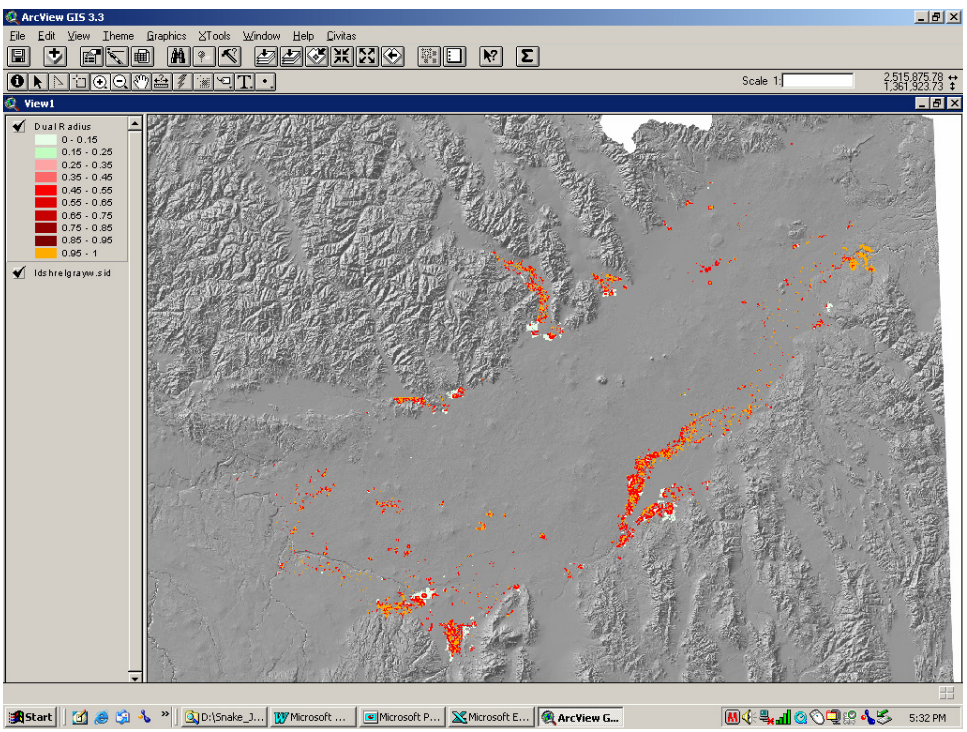

Figure 6. Dual-Radius indication of ground-water fraction of supply on mixed-source lands.

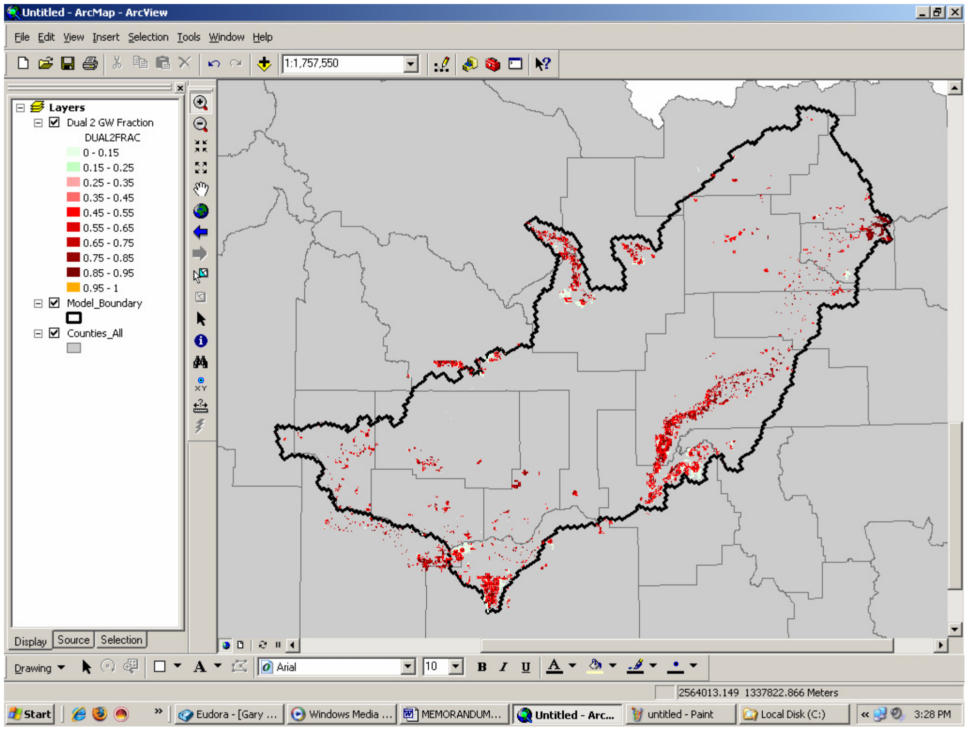

Figure 7. Dual 2 indication of ground-water fraction on mixed-source lands

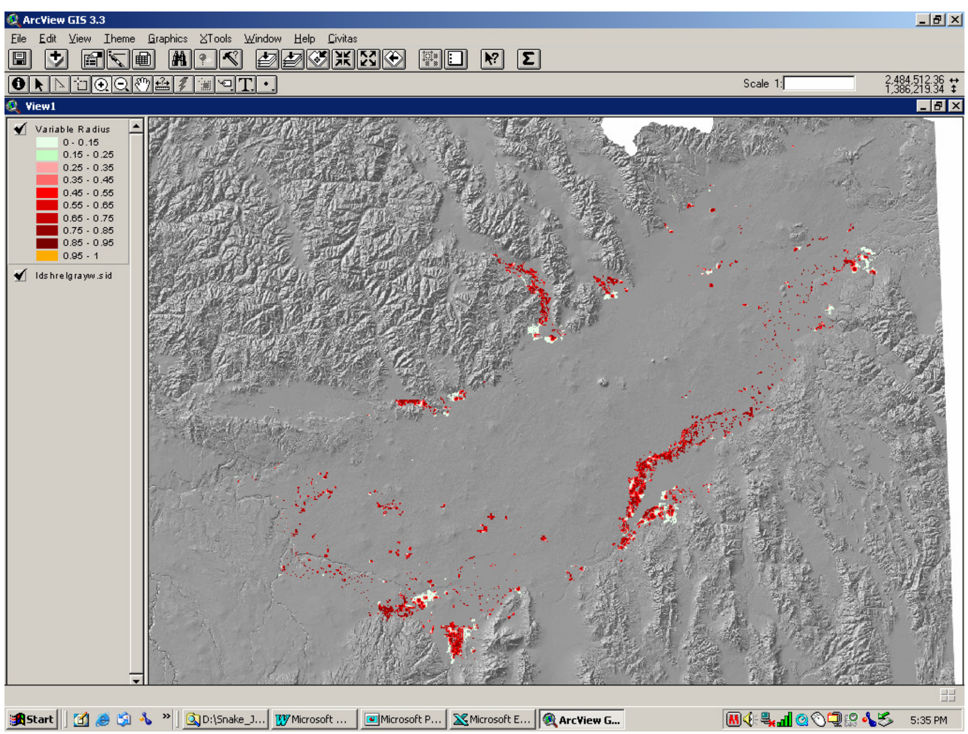

Figure 8. Ground-water fraction on mixed source lands using the Variable Radius method.

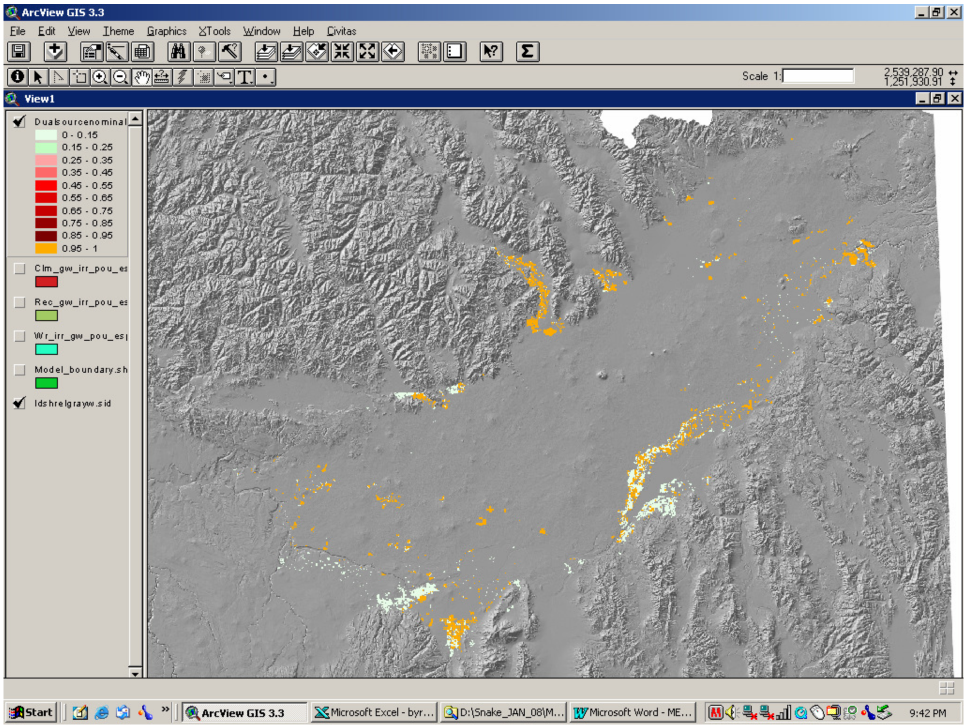

Figure 9. Ground-water fractions from the "No Company" method.

Figures 10 through 15 zoom in on the area around the Near Blackfoot to Neeley reach, since this area has significant mixed-source acreage near to a reach of concern.

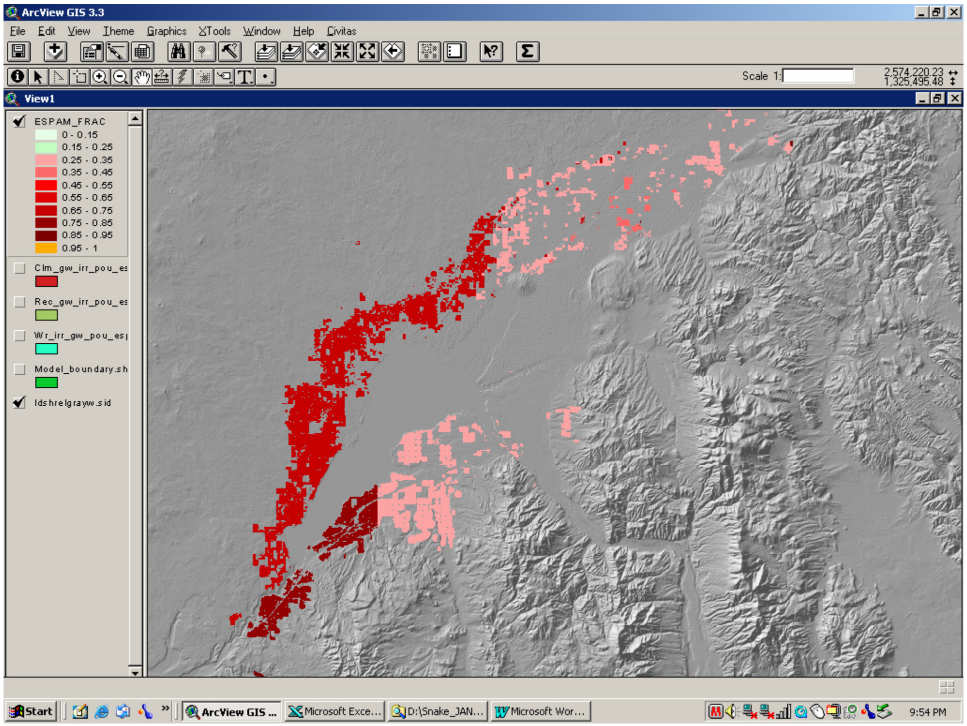

Figure 10. Source fraction in ESPAM 1.1 data, Near Blackfoot to Neeley reach.

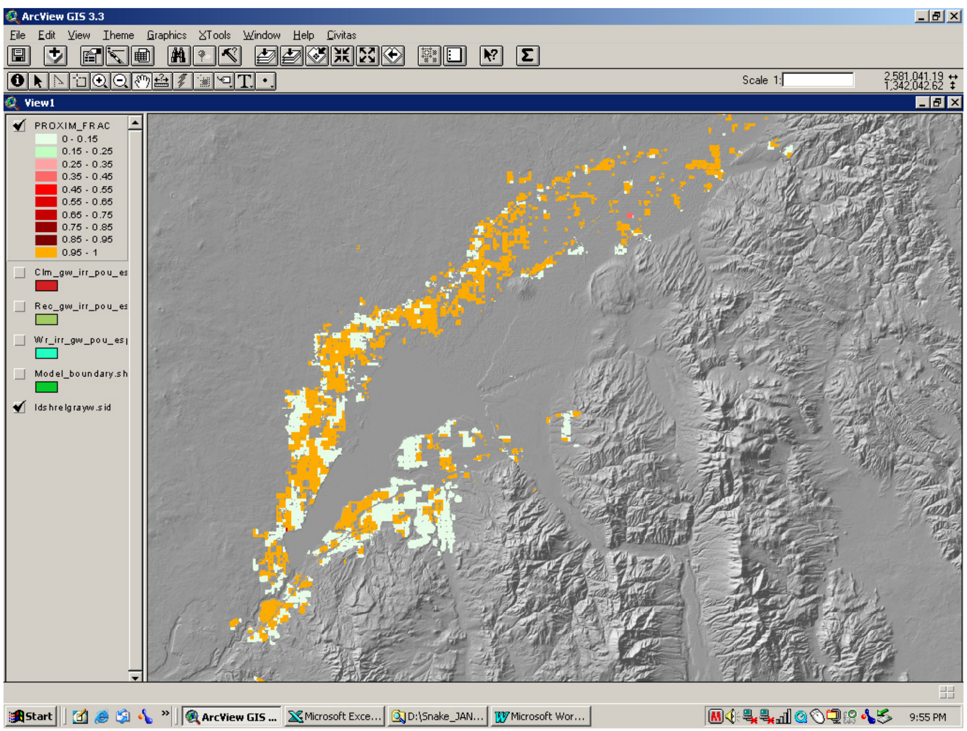

Figure 11. Source fraction by Proximity method, Near Blackfoot to Neeley reach.

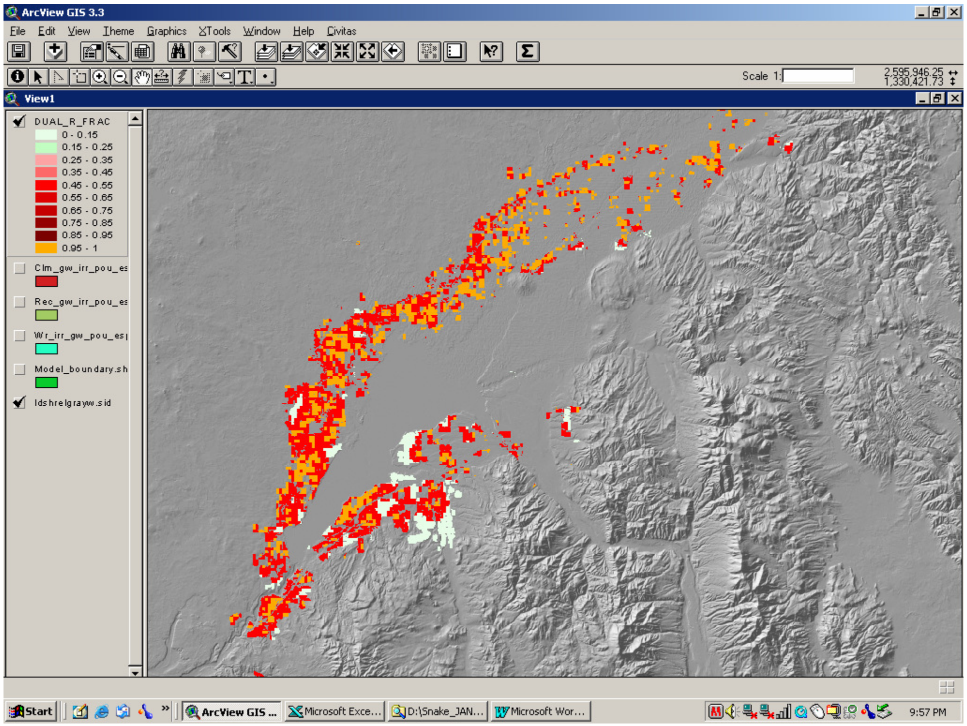

Figure 12. Source fraction by Dual Radius method, Near Blackfoot to Neeley reach.

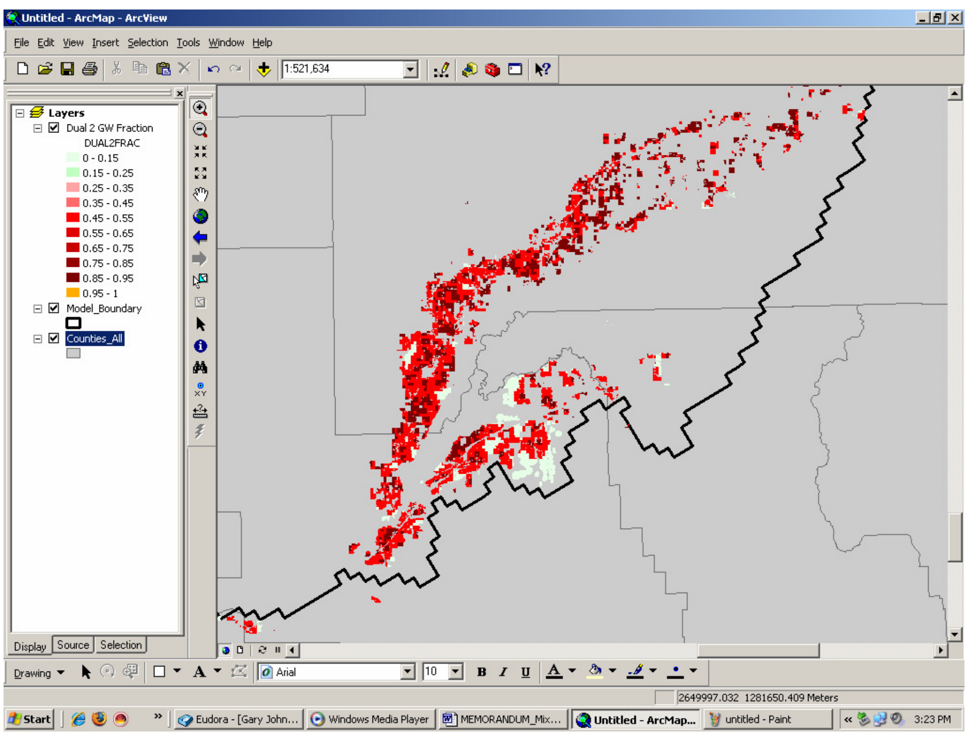

Figure 13. Source fraction by the Dual 2 method in the Near Blackfoot to Neeley area.

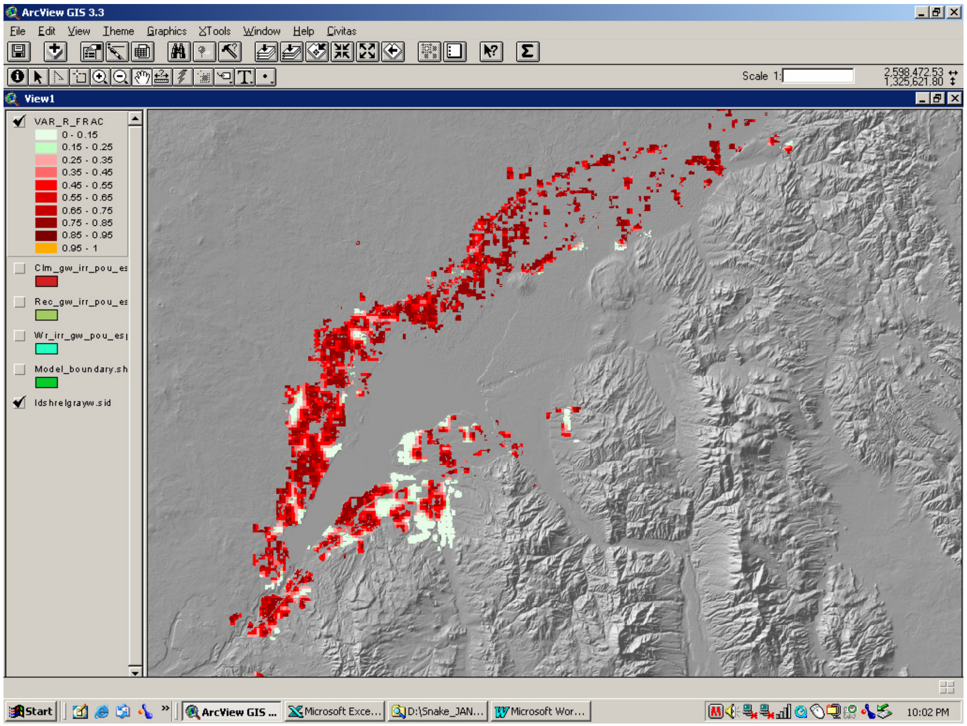

Figure 14. Source fraction by Variable Radius method, Near Blackfoot to Neeley reach.

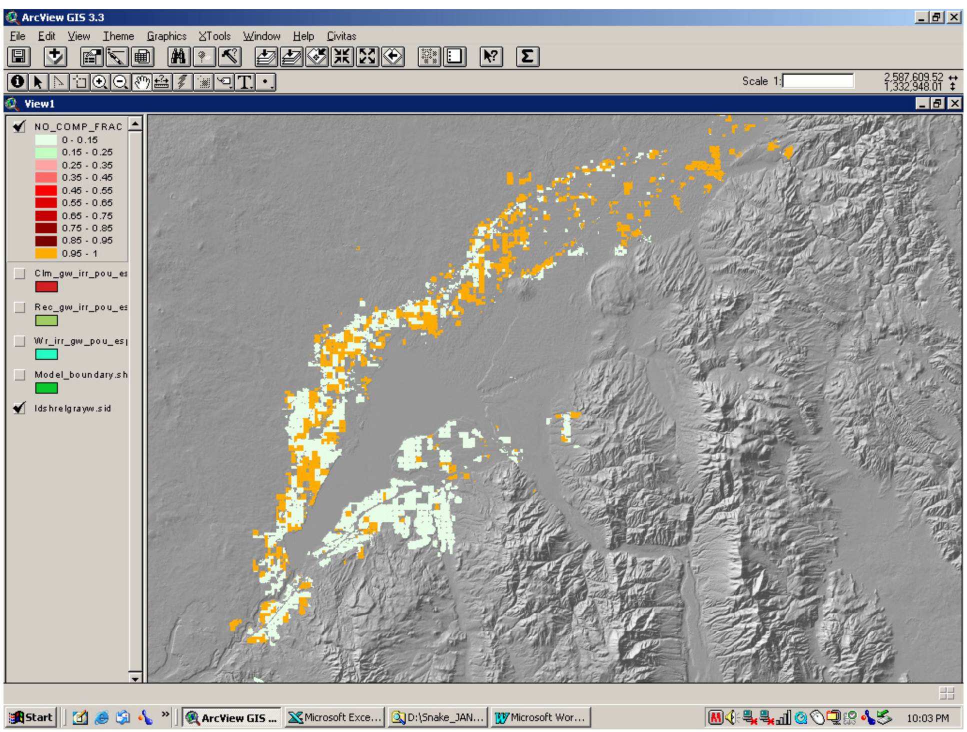

Figure 15. Source fraction by No Company method, Near Blackfoot to Neeley reach.

Figure 16 shows the comparison of total effective ground-water acreage on mixed-source lands in the Near Blackfoot to Neeley region.

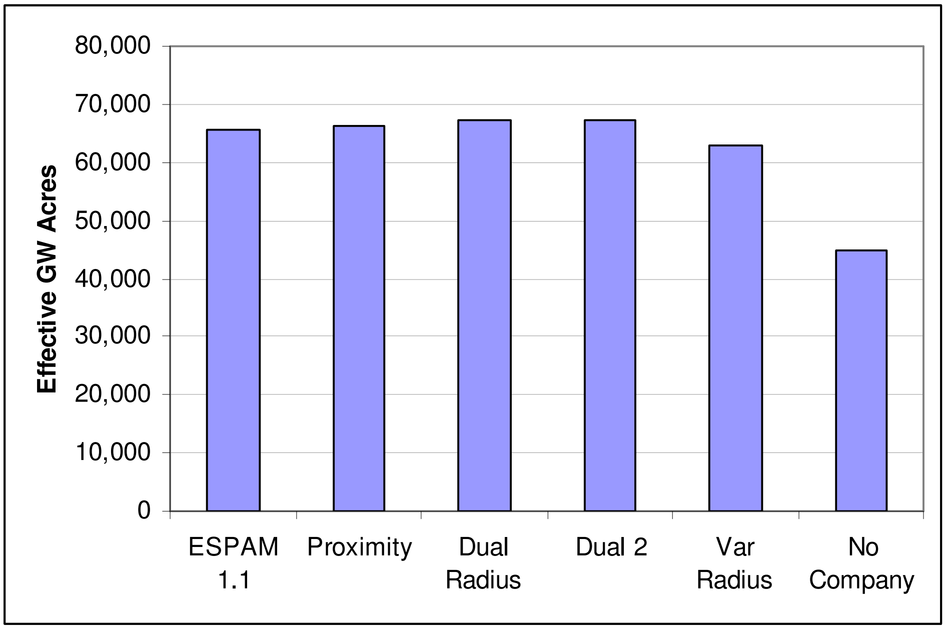

Figure 16. Comparison of effective ground-water irrigated acres on mixed-source lands in the Near Blackfoot to Neeley area.

To further consider the spatial distribution of ground-water fraction, the areas shown in Figure 17 were considered separately. Figure 18 displays the fraction of supply on mixed-source lands that is indicated by each of the methods.

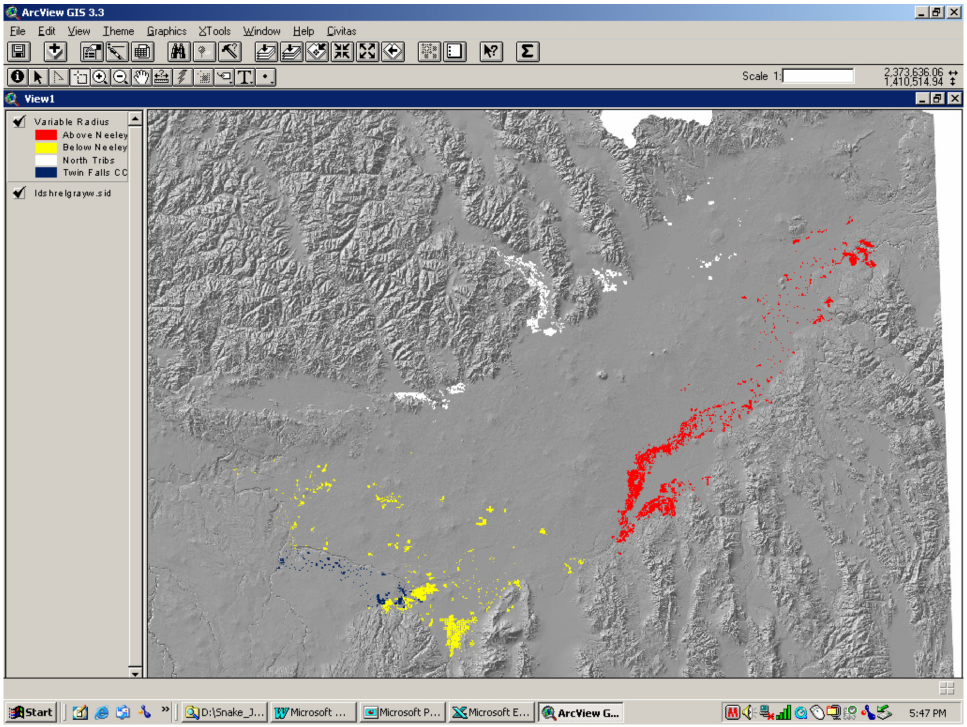

Figure 17. Regions for comparison of ground-water fraction.

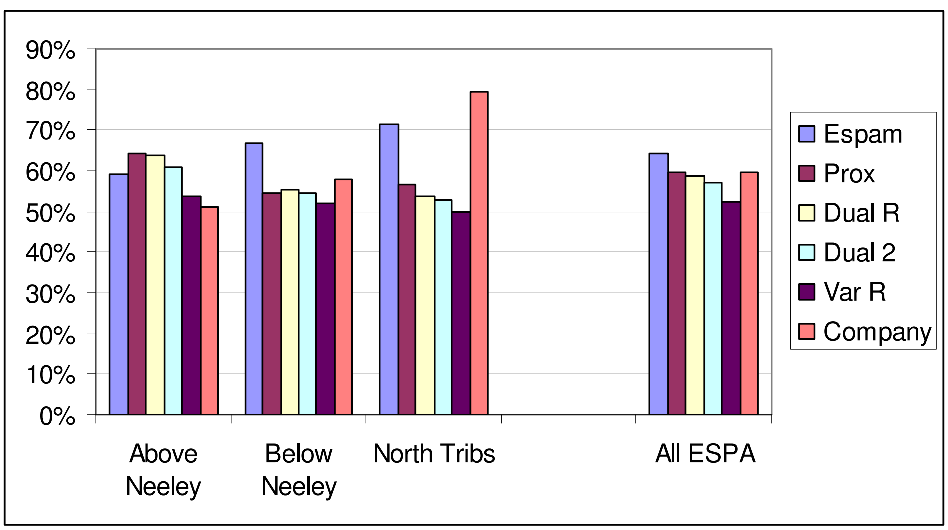

Figure 18. Comparison of ground-water fraction within regions.

Finally, cross-plots of the effective ground-water acres within mixed-source lands of each surface-water irrigation entity were prepared, comparing the alternate-method acreage with the ESPAM 1.1 acreage. These are shown in Figure 19 and Figure 20.

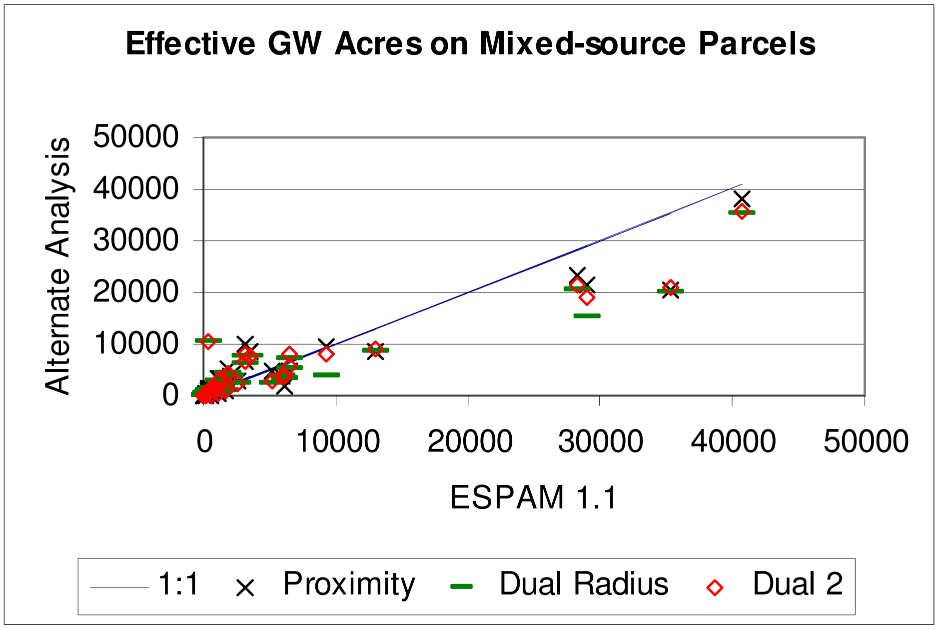

Figure 19. Cross Plot of total effective ground-water acreage by irrigation entity for alternate methods.

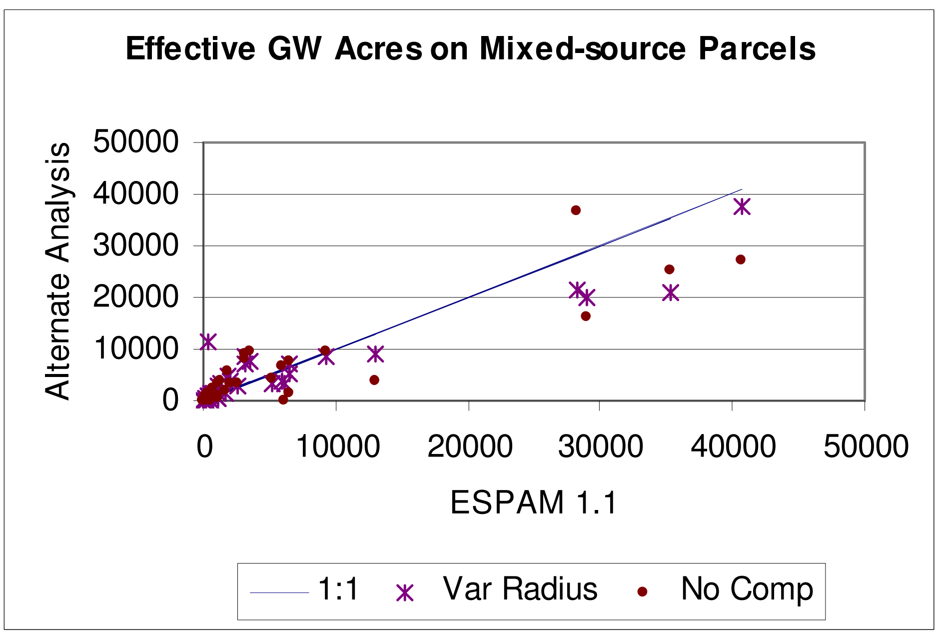

Figure 20. Cross Plot of total effective ground-water acreage by irrigation entity for alternate methods.

DISCUSSION

In considering these results, several points are important:

1. The treatment of mixed-source lands will not affect the total calibration water budget.
2. The treatment of mixed-source lands will not change the distribution or allocation of water *between* irrigation entities in calibration.
3. The water budgets of individual irrigation entities will not change.
4. The only effect of mixed-source lands on calibration will be on spatial distribution of recharge *within* each irrigation entity.
5. The ESHMC identified one location where the spatial distribution within an entity might make a difference in calibration. The test described above indicated that the potential effect is small relative to total gains in the nearby reach.
6. While comparisons with the ESPAM1.1 representation are interesting, ***we have no reason to believe the ESPAM1.1 representation is more correct*** than the alternate methods.

It does not appear that there is any strong technical reason to favor any of the methods over another. However, perceptions of the resulting representations may be important. There are several potential perception problems with these methods:

1. The ESPAM1.1 representation could be rejected on perception grounds because it shows surface-water and ground-water distributed with perfect uniformity across all mixed-source lands in each entity.
2. The Proximity, Dual Radius and No Company methods identify particular mixed-source parcels as 100% ground-water supplied or 100% surface-water supplied. Many individual parcels will be incorrectly identified, and individuals will probably spot some of these errors.
3. The No Company method implies that all parcels with private ground-water rights are ground-water only and all parcels with company-owned ground-water rights are surface-water only.
4. The Variable-Radius method is complicated and may indicate more precision than the data actually support.

At the ESHMC meeting it was suggested that changing the mixed-source representation may affect curtailment calculations. This is true; Figure 18 shows different indicated ground-water acreage in various regions, by method. While this will not affect calibration, it would affect curtailment estimates. There are a few points to keep in mind regarding curtailment:

1. There is no strong technical indication that any one method is more technically correct than another.
2. Modeling decisions should be based on modeling and calibration considerations.

3. What would actually happen on mixed-source lands under curtailment depends on the ability of users to obtain replacement surface-water supplies and the infrastructure to use them on mixed-source lands. These factors probably introduce far more uncertainty into considerations of curtailment than the differences between these methods.
4. There is no particular reason that IDWR in its curtailment analysis must follow the methods used in model calibration.

IDWR has expressed interest in the ability to update the mixed-source fractions periodically, as is done with the “POD file” discussed by Allan Wylie at the January 2008 ESHMC meeting. An update could be easily made using any of the proximity methods by simply repeating the GIS radius search with a new POD file. The “no company” method could be quite quickly updated, as well, using a new IDWR place-of-use file, if only the “large place of use” data field criterion is used. An informal comparison suggests that within the aquifer boundary this less rigorous criterion produces essentially the same results as the “no company” method used here, though there are some differences in areas outside the model boundary.

RECOMMENDATION

IWRRI's preliminary recommendation is to use the Dual 2 method. Labels and discussion should describe the fractions as *probabilities* that a parcel receives ground water, in order to reduce perceptions or expectations that we have actually determined the physical source of water for particular mixed-source parcels.

The Dual 2 method is selected because it seems to avoid the worst of the perception issues, is simpler than the Variable Radius method, and can be quickly updated with a new POD file when desired.