A protocol for the construction of yield maps from data collected using commercially available grape yield monitors.

Supplement No. 2. April 2008 - Accounting for 'convolution' in grape yield mapping

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Important Note: This supplement should be read in conjunction with the original yield mapping protocol of Bramley and Williams (2001) and Supplement No. 1 (Bramley, 2005).

'Convolution' is a term which Precision Agriculture practitioners have given to errors in the matching of yield monitor data records to GPS coordinates corresponding to the location from which the yield came. It is caused by the time delay between the point at which the crop is harvested, and the point at which yield is recorded, and the associated positional error resulting from the logging of GPS coordinates at the same time as logging of yield. In broadacre grain crops harvested with combines that may be several metres wide, this delay may be as much as 30 seconds or more, and varies for grain harvested at the edge of the header compared to that in the centre. Early work in grain yield monitoring focussed on this problem (eg. Pringle et al., 1999) and grain yield monitoring software generally seeks to account for it.

When we produced the original winegrape yield mapping protocol (Bramley and Williams, 2001), we believed that the positional error caused by the time taken for grapes to get from the point of harvest to the yield monitor was small; grape harvesters move at a slower speed than grain combines, and since only one row is harvested at a time, the error caused by the time delay only occurs in one direction. Whilst acknowledging that some error nevertheless existed, we were of the view that the effects of this were removed by the use of local block kriging (blocks of 10 m – see Bramley and Williams, 2001). In general, we still believe this to be the case, although from time to time, the effects of the time delay can be clearly seen in grape yield maps and is enhanced by the common practice of harvesting in a 6 or 7 row pattern (eg Figure 1a).

Repeated measurements conducted on an ad hoc basis over several vintages at a range of locations suggests that the time delay between the start of harvesting and grapes moving over the yield monitor ranges between 6 and 16 seconds (equivalent to around 6-16 m) depending on a range of factors such as the speed of the harvester, the belt speed on the discharge shute, the length of the shute, position of the yield monitor and other factors associated with the configuration of the harvester. Systems with weighing sensors installed on cross conveyors tend to have shorter time lags than slow-moving tow-behind harvesters. In our experience, the time lag is most typically around 12 seconds and in this note, we assume this to be so. Users who wish to know exactly what the lag is that applies to their harvester can easily time measure it by throwing a table tennis ball into the picking head and timing how long it takes to reach the yield monitor. Alternatively, by assuming a 12 second lag and using block kriging as explained in the main protocol, most convolution effects should be removed.

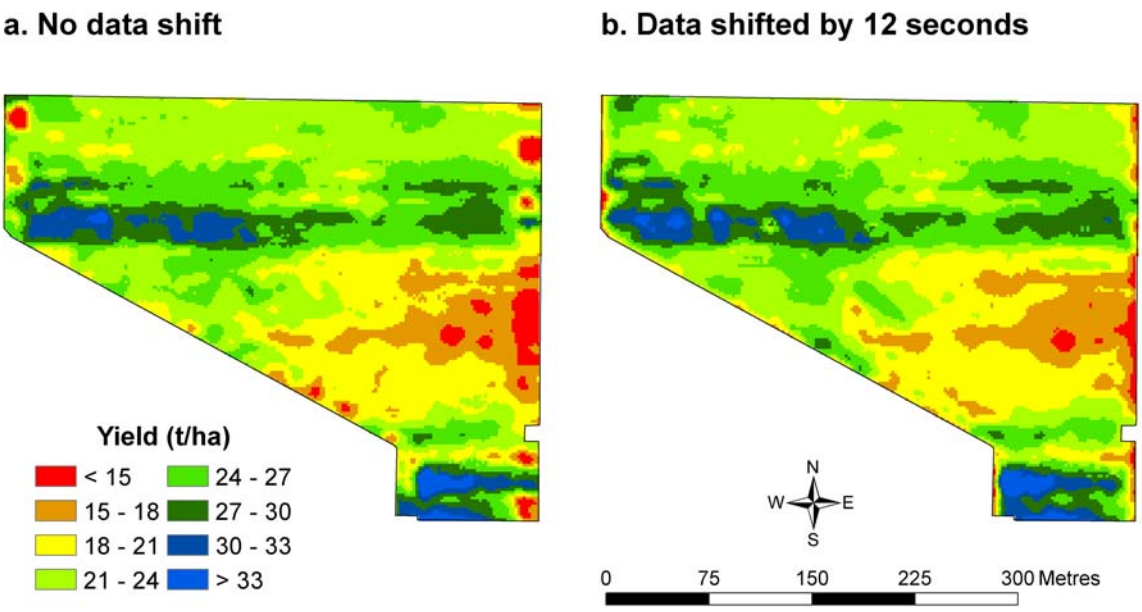

Figure 1. Yield in an 8 ha Sunraysia block of Cabernet Sauvignon, 2006. In (a) note the enhanced areas of low yield on the eastern and western ends of rows corresponding to the 6 row pattern used by harvester. In (b) the effects of convolution have been removed by applying a 12 second shift to the yield monitor data. As a consequence, the harvester pattern is no longer evident.

Comparison of Figure 1b with Figure 1a shows the effect of accounting for the time delay between the start of harvesting and grapes moving over the yield monitor in the yield mapping process. The remainder of this note explains how to 'shift' logged yield data so as to remove its effect from yield maps.

A note for Farmscan™ users

The Farmscan yield monitoring system comes with software (the Farmscan™ Data Manager) for data manipulation, mapping and display. This includes a feature for 'data shifting'. Note that in some earlier versions, there appeared to be an error in the software in that when the shift was used, it was displayed on screen, but not retained in exported data. This problem has been corrected in version 4.0, build 63.

To activate the shift, proceed as follows:

1. On the 'Map Analysis' menu, select 'Settings', and in the section of this tab entited 'Shift', set the number of logging intervals to '-4' (Figure 2). Note that this setting assumes that the yield monitor is set to log at 3 second intervals, as per the original protocol (Bramley and Williams, 2001).

2. With a map displayed, select 'Shift' in the 'Map Analysis' menu, and the shift will occur automatically.

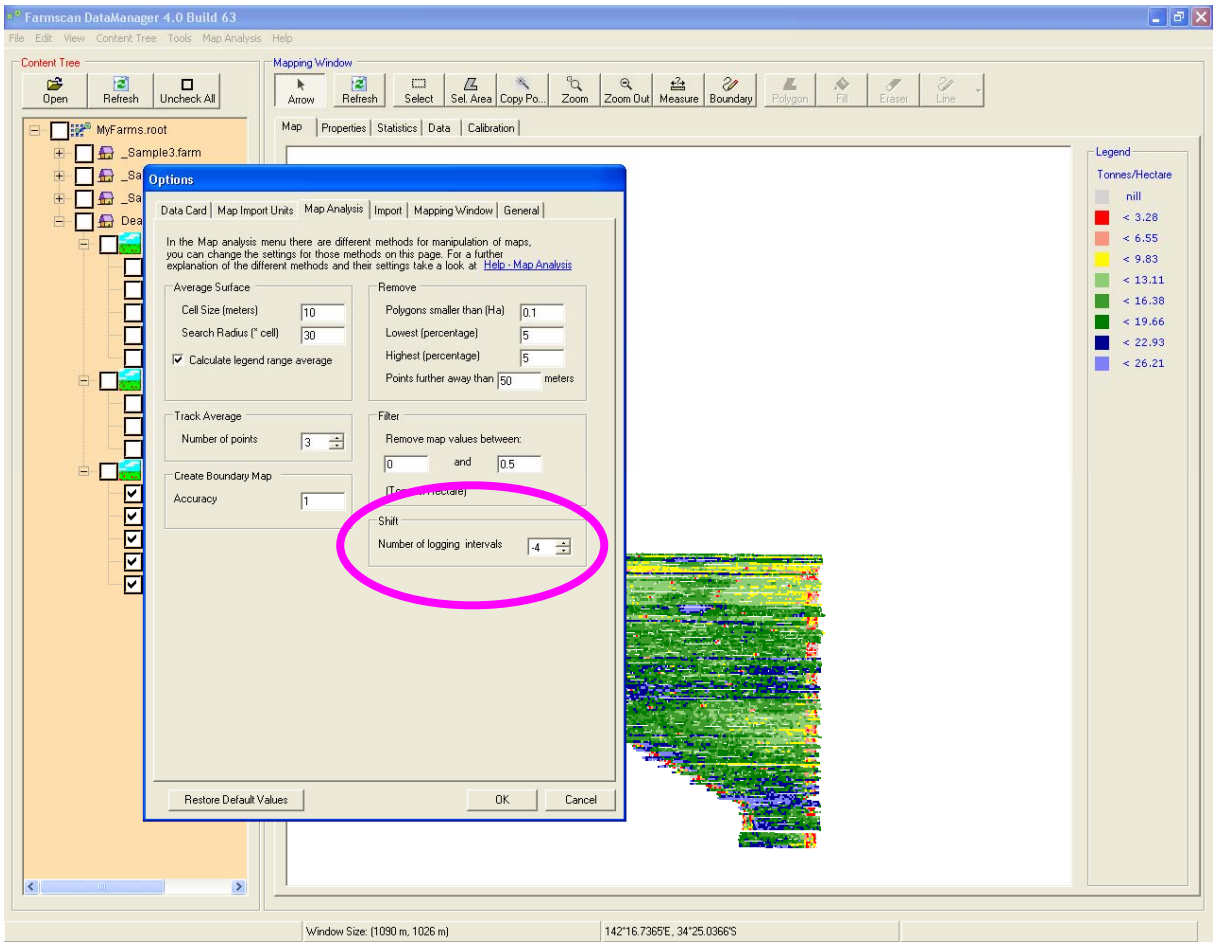

Figure 2. Configuration of the 'Shift' setting in the Farmscan™ Data Manager.

3. Deselection of the map in the 'Content Tree' leads to a request to save the shifted map. If you wish to do this, we suggest that you modify the filename from the original to indicate that the shift has been implemented. Alternatively, with the map still displayed, select 'Save map as' in the 'File' menu and choose the appropriate option. Note that in Supplement No. 1 (Bramley, 2005), we recommended selection of the 'Comma delimited UTM (*.csv)' option as this export also converts latitudes and longitudes (decimal degrees) to an Eastings and Northings (m) basis.

The resultant exported file can then be opened in a spreadsheet program such as Excel for further manipulation, including data cleaning and trimming (Bramley, 2005) and subsequent interpolation of a yield map (Bramley and Williams, 2001).

A note for users Advanced Technology Viticulture yield monitors.

The yield monitoring systems produced by Advanced Technology Viticulture have different methods for 'data shifting', depending on whether the Windows-PC based system or self-logging system is used.

For ATV yield monitors with Windows-based computers and the 'Grape Yield Scan' software:

Any offset for the 'mass flow delay' as well as for the position of the GPS antenna can be pre-configured in the GPS Setup (F4) menu as shown in Figure 3.

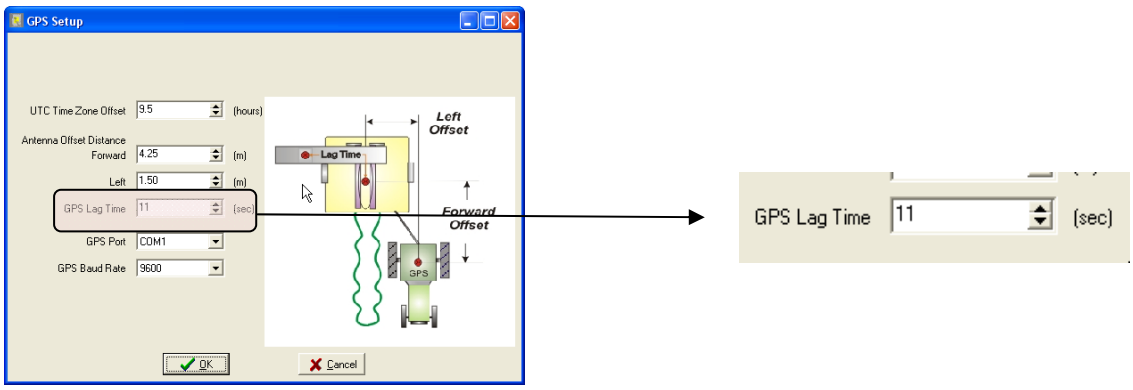

Figure 3. Adjusting the GPS lag time in the ATV *Grape Yield Scan* software.

For ATV yield monitors with the integrated 'Grape logger':

The data merging software 'ATV Datalog Converter' (from version 0.4.3, build 071123 on) is used to implement the shift as follows:

Having selected the data file to be shifted (this file will have the suffix -GPS.txt), the 'shift' can be adjusted in intervals of seconds using the 'GW Time Offset' toggle (Figure 4).

Note that, because the yield data generally have to be moved backwards in time relative to the GPS data, the value of the 'GW Time Offset' is normally negative. Note also that the time selection has to be done before starting the merging procedure.

The value for the 'GW time offset' is reported in the last column of the raw yield data export file.

Conclusion

Use of a data shift of 12 seconds or 4 logging intervals, followed by data cleaning and trimming (Bramley, 2005) and yield map production using the standard protocol (Bramley and Williams, 2001) results in robust yield maps of grape yield. We recommend that the data shift outlined in this supplement be incorporated into all grape yield mapping procedures.

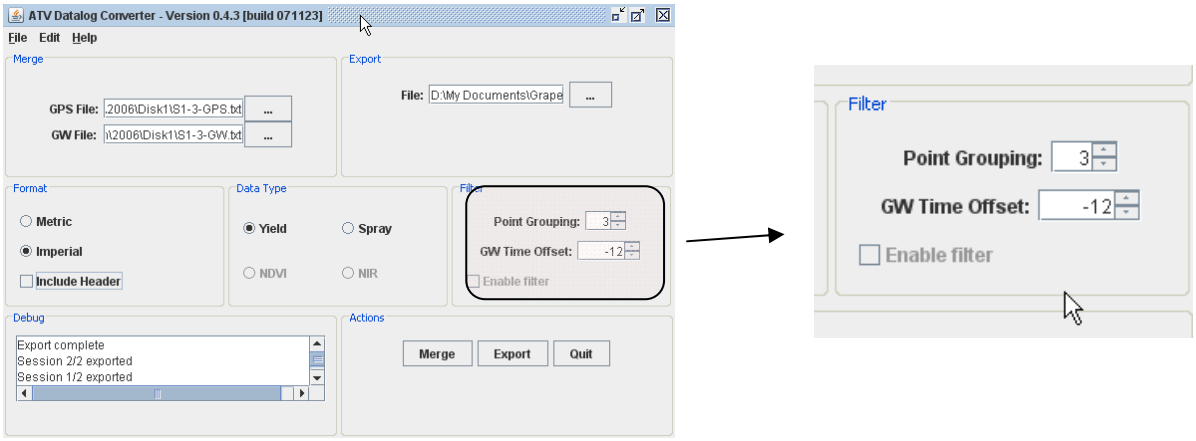

Figure 4. Adjusting the GPS lag time using the ATV *Datalog Converter* software

References

Bramley, R. 2005. A protocol for the construction of yield maps from data collected using commercially available grape yield monitors. Supplement No. 1. February 2005. www.cse.csiro.au/client_serv/resources/protocol_supp1.pdf

Bramley, R.G.V. and Williams, S.K. 2001. A protocol for the construction of yield maps from data collected using commercially available grape yield monitors. Cooperative Research Centre for Viticulture. www.cse.csiro.au/client_serv/resources/CRCVYield_Mapping_Protocol.pdf

Pringle, M.J., Whelan, B.M., Adams, M.L., Cook, S.E. & Riethmuller, G. (1999). Yield deconvolution - A wetted grain pulse to estimate the grain transfer function. In P.C. Robert, R.H. Rust & W.E. Larson (eds) *Precision Agriculture, Proceedings of the 4th International Conference on Precision Agriculture,* ASA/CSSA/SSSA, Madison, Wisconsin. (1177-1184).

Readers may also find other useful information at:

www.csiro.au/science/PrecisionViticulture.html