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Discussions

Interactive comment on "Contrasts between chemical and physical estimates of baseflow help discern multiple sources of water contributing to rivers" *by* I. Cartwright et al.

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This paper provides useful insights into the various potential inputs to streamflow by comparing physical and chemical approaches to baseflow separation. It reinforces that both quickflow and baseflow can have multiple sources and that the contributions from these sources can vary significantly over the flow regime. Specific comments mainly relate to apparent inconsistencies and additional clarification:

(1) The baseflow definition in the Introduction assumes that baseflow is only derived from delayed storages in the unsaturated and saturated zone, whilst other storages may theoretically be involved (such as snow melt or return flows from connected lakes etc). This leads to an inconsistency, as the example of draining of floodplain pools is

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given later in the paragraph.

(2) The literature review of the comparison of chemical and physical baseflow separation methods could really be expanded. A cursory search came up with some additional references that may be relevant– see below.

(3) The salinity of the return flows from bank storage is assumed to be similar to surface water which may not be the case. Such return flows may involve mobilisation of salt stores in the near-river geological profile. The geological description of the catchment suggests that there are examples of such salt stores in low-lying areas of the floodplain.

(4) The description of local geology and hydrogeology, although cursory, suggests that the catchment is hydrogeologically complex, consisting of a combination of sedimentary sequences, volcanics with interbedded sediments, as well as alluvial deposits. There is no summary of the hydraulic connection of these different units to the river (and to each other). There is the potential for multiple groundwater systems to be operating at different scales (eg regional, intermediate and local flow systems) that could be contributing baseflow of varying magnitude over different time scales. At a minimum, there needs to be a simplified hydrogeological map of the catchment as well as schematic cross sections that summarise the different scenarios for groundwater-surface water interaction in the catchment.

(5) The chemical mass balance approach is based on a constant groundwater salinity. This is difficult to reconcile considering (i) the hydrogeological complexity and the huge variation in groundwater salinity observed in the catchment and (ii) much of the shallow groundwater being 3500-13000 mg/L (P 5949) and so significantly above the 3200 EC (2100 mg/L) threshold used. There needs to be a discussion about what the 3200 EC figure actually represents – is this an aggregate of all the various groundwater inputs upstream of the gauge, does it reflect a particularly dominant groundwater input in a particular reach, does it reflect a degree of freshening of shallow groundwater near the river, etc.

(6) The flow duration curves for the representative years (Figure 5) appear to have some inconsistencies. The 2002 year was chosen to represent the long-term median, but is the one that has the most persistent low flows (<10 ML/d). The 2001 year is the high discharge example, as represented by the greater occurrence of flows >100 ML/d. However, at 100 ML/d the flow duration curve changes abruptly, and low flows are more typical of normal conditions. These features in the low-flow part of the flow duration curves need to be explained. In contrast, the 2006 year appears to be a good representation of a low discharge year.

(7) The sentence summarising the annual discharge at Winchelsea (p 5950, line 21-22) does not match Table 1. Perhaps all flow/baseflow figures referred to in text need to be checked.

(8) River EC values > 3500 uS/cm have been interpreted to reflect evaporation during stagnant conditions (page), however the discharge of saline groundwater cannot be ruled out.

(9) The surface runoff EC is assumed to be the same as the local rainfall. However, the surface runoff may be significantly higher, considering the extent of near-surface salt stores that is apparent in the catchment.

(10) I found it difficult to differentiate the time series of the various baseflow curves (Figures 2-4). It would also be useful to have time series of the ratios of the physical baseflow estimates to the chemical mass balance baseflow – especially to reinforce some of the points made in the discussion.

(11) The differences between EC predicted from the physical baseflow methods and the actual EC record for discharge events (Figure 7) need further discussion. There are differences between events – for some the calculated EC values return to high values on the falling limb (such as events 3 and 4) whilst for others the falling limb EC values are relatively low (such as events 1 and 2) – what is the significance of this?

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(12) The physical baseflow estimates have input parameters that are largely empirical or subjective (eg N, BFI-max). The study would benefit from a sensitivity analysis to derive the potential range of baseflow estimates when low and high estimates of these input parameters are applied. These ranges should then be compared with ranges of baseflow derived from a similar sensitivity analysis undertaken for the chemical mass balance approach (by having low and high estimates of surface runoff EC and groundwater EC). This would be a better representation of the level of uncertainty embedded in these two methods.

Caissie, D, Pollock, TL Cunjak, RA, 1996. Variation in stream water chemistry and hydrograph separation in a small drainage basin. Journal of Hydrology 178(1-4), 137-157 Sanford, WE, Nelms DL, Pope, JP Selnick, DL, 2012. Quantifying components of the hydrological cycle in Virginia using chemical hydrograph separation and multiple regression analysis. SIR 2011-5198, US Geological Survey Stewart, M, Cimino, J Mark, R, 2007. Calibration of base flow separation methods with streamflow conductivity. Ground Water 45(1), 17-27

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