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Interactive comment on "Constraints of artificial neural networks for rainfall-runoff modelling: trade-offs in hydrological state representation and modelevaluation" *by* N. J. de Vos and T. H. M. Rientjes

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Constraints of artificial neural networks for rainfall-runoff modelling: trade-offs in hydrological state representation and model evaluation.

by N.J. de Vos & T.H.M. Rientjes

General Comments This is a well-written paper that addresses the problem of the selection of appropriate input parameters for ANN models. I have addressed this specific issue on a number of occasions in the past and it is refreshing to see how the authors have now discussed this issue in relation to the inherent timing errors in ANN rainfall-runoff models. These input parameters may be derived from simple measurements or may even be highly intuitive, and are unrestricted in terms of conditions of dimension or hydrological-physical consistency (Minns, 1996). The selection of inputs, whether data as recorded or variables derived from operations on recorded data, requires the application of hydrological insight as much as any conventional physical/conceptual rainfall-runoff model. Provided that such insight is applied, the performance of ANN models can be undoubtedly superior to conventional hydrological models in situations that do not require more detailed knowledge of the hydrological system. (Minns & Hall, 2004).

This paper stands out even further from other papers on the same topic by also discussing in some detail the shortcomings involved with the use of traditional error measures such as the coefficient of efficiency and/or a mean-square error.

In this respect, it is perhaps a little disappointing that the paper spends too much time describing how ANN works, which training algorithm is used and how the authors arrived at their final configurations. This information is not new or innovative and can be found in countless papers and books on the same subject. It should be treated here much more succinctly as background information to the true problem at hand - that is, how to determine appropriate model inputs and how to address the model output errors. The first half of the paper thus lacks focus, does not present anything particularly 'new' and is simply the presentation of a 'standard' application of ANN to rainfall-runoff modelling. The merit of this paper is in the second half!

Specific Comments Section 1 and Sections 2.1, 2.2 and 2.3 could probably be shortened and combined to give a more succinct introduction and background rather than covering all of the standard ANN issues that are now common knowledge. For readers unfamiliar with this technique, you can refer to one of the many excellent textbooks on this subject.

Figures 6, 9, 10, 11, 12, 13, et seq. show results from the ANN model. Are these

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results all using the testing data set? I assume that this is so but it is not explicitly stated in the main text.

Section 3.3 mentions a standardisation range of -0.8 to 0.7 in order to allow extrapolation. Unfortunately, this modification of the standardisation range only provides a very limited extrapolation on the results (see Minns, 1996). Have the authors examined how much of a problem they have with extrapolation in their particular case? That is, do the maxima in cross-validation and validation data sets significantly exceed the maximum value in the training data set?

Is Section 3.4 really relevant to the current paper?

Section 4.1, page 381, line 17: The problem with prediction lags was identified already by Minns (1998), which is also summarised in Minns & Hall (2004). Varoonchotikul (2003) addressed this problem by using recurrent neural networks to feed back the modelled phase error. It is therefore not entirely correct to say that "Ě no previous researchers have appreciated prediction lags in ANN model forecasts Ě". It would, however, be fair to say that no-one has yet been successful in developing a robust methodology for handling this problem.

Section 4.1, page 382, line 3: The authors have mentioned that the importance of the prediction lag is not always significant. It would be useful to place this in a little more perspective. The authors need to address the issue of whether it is more important to have an accurate estimation of the peak flow or an accurate estimation of the timing of the peak. Even though we would prefer to have both, it is sometimes necessary to make comprises for the sake of expediency. For catchments with a long time-to-peak of several days or more, it is really not at all important if the timing of the peak flow is wrong by a few hours. On the other hand, for catchments subject to flash floods, the timing is far more important.

Section 4.3: Having determined in the rest of the paper that one of your prime objectives is to reduce the prediction lag, it is a shame that this section does not build

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significantly further on your conclusions. Just stating that the error measures are probably not sufficient is a rather disappointing conclusion to this otherwise well structured research paper. Problems with the error measures have already been identified by many other authors and, in particular, Hall (2001) demonstrates the effect of timing errors upon the values of traditional error measures like the coefficient of efficiency. The authors of the current paper have identified a major problem without suggesting any possible solutions or tips on how to address this.

Technical Corrections Section 3.3, line 10: replace the word ‘less’ with ‘little’

Section 4.2: As far as I am aware, ‘representator’ is not an English word. I believe the authors are referring to ‘state indicators’ or ‘state parameters’.

Fig 15, page 409: The horizontal axis should probably be labelled as ‘Time shift’.

All figures: could the authors please review all of their figures and provide appropriate labels on all of the vertical and horizontal axes (including units where appropriate).

References Hall, M.J., 2001, How well does your model fit the data?, Journal of Hydroinformatics, 3(1), pp. 49-55. Minns A.W., 1996, Extended rainfall-runoff modelling using artificial neural networks, Hydroinformatics ‘96, Proc. 2nd International Conference on Hydroinformatics, ETH-Zürich, Balkema, Rotterdam, pp. 207-213. Minns, A.W., 1998, Artificial Neural Networks as Sub-symbolic Process Descriptors, PhD thesis, Balkema, Rotterdam, 124 pp. Minns, A.W. & Hall, M.J., 2004, Rainfall-runoff modelling, in Neural Networks for Hydrological Modelling, Abrahart, R.J., See, L. & Kneale, P.E. (eds), Balkema, Rotterdam., pp. 159-177. Varoonchotikul, P., 2003, Flood Forecasting using Artificial Neural Networks, Zwets & Zeitlinger, Lisse, 120 pp.

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