Wavelets-based non-linear model for real-time daily flow forecasting in Krishna River

APPENDIX: VOLterra MODEL

The Volterra series of integral operators was introduced by Volterra (1930) and has since been developed into a powerful generic non-linear modelling tool. The domain of applied hydrology has also seen the application of a Volterra-representation-based approach. Some notable contributions have been made by Amorocho & Orlob (1961) and Amorocho & Brandstetter (1971).

\[ Y(t) = \int_{0}^{t} h_1(\tau_1)X(\tau - \tau_1)d\tau_1 \\
+ \int_{0}^{t} \int_{0}^{\tau_1} h_2(\tau_1, \tau_2)X(\tau - \tau_1)X(\tau - \tau_2)d\tau_1d\tau_2 \\
+ \int_{0}^{t} \int_{0}^{\tau_1} \int_{0}^{\tau_2} h_3(\tau_1, \tau_2, \tau_3)X(\tau - \tau_1)X(\tau - \tau_2)X(\tau - \tau_3)d\tau_1d\tau_2d\tau_3 + \ldots \quad (A1) \]

Volterra representation is a simple extension of the Taylor series for non-linear autonomous causal systems with memory, and may be written:

\[ Y(t) = H_1[x(t)] + H_2[x(t)] + H_3[x(t)] + \ldots + H_n[x(t)] + \ldots \quad (A2) \]

where \( Y(t) \) represents the system output and \( x(t) \) denotes the input to the system. The functions \( h_n(\tau_1, \tau_2, \ldots, \tau_n) \) in Equation (A1) are called the Volterra kernels of the system and the transformation \( H_n[x(t)] \) in Equation (A2) represents a special type of a convolution integral known as the \( n \)th order Volterra operator. Figure A1 shows a schematic representation of the Volterra model in the form of a block diagram.

REFERENCES