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# Advances in the Spatially Distributed AgES-W Model: Parallel Computation, Java Connection Framework (JCF) Integration, and Streamflow/Nitrogen Dynamics Assessment

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# Advances in the Spatially Distributed AgES-W Model: Parallel Computation, Java Connection Framework (JCF) Integration, and Streamflow/Nitrogen Dynamics Assessment

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**Abstract:** AgroEcoSystem-Watershed (AgES-W) is a modular, Java-based spatially distributed model which implements hydrologic and water quality (H/WQ) simulation components under the Java Connection Framework (JCF) and the Object Modeling System (OMS) environmental modeling framework. AgES-W is implicitly scalable from field to regional scales, has a unique four-compartment surface-groundwater (vertical/lateral) routing scheme, and has recently been enhanced with various science components and tools for improved prediction of H/WQ response across large gauged and ungauged areas. Science component improvements include both new and enhanced modules for infiltration, water conveyance (e.g., ditches and diversions), conservation practice effects, and water table tracking. Recent AgES-W modeling developments include integration of AgES-W science components under the JCF in order to resolve connectivity issues within the existing model architecture and addition of multiple methods for parallel computation of surface/subsurface processes within AgES-W across spatial land units. Specific objectives of this research study include: 1) assessing the computational performance and scalability of the implemented parallelization methods across a range of CPU utilization (i.e., processor cores/threads), and 2) evaluating the accuracy and applicability of the enhanced AgES-W model for estimating streamflow and nitrogen (N) dynamics for the South Fork Watershed (SFW) in central Iowa, USA. AgES-W model performance for SFW streamflow/N dynamics was assessed using Nash-Sutcliffe efficiency (ENS), root mean square deviation (RMSD), and relative error (PBIAS) statistical evaluation coefficients. Comparisons of simulated and observed daily and average monthly streamflow/N resulted in ENS, RMSD, and PBIAS values that were within the range (or better) of those reported in the literature for other H/WQ models at a similar scale and time step. Comparison of the parallelization approaches showed that each method exhibited trade-offs in thread synchronization cost, added complexity of the AgES-W code, and the “breadth” of parallelism that may be achieved.

**Keywords:** Hydrologic and water quality modeling; Parallel computing; Streamflow; Nitrogen; Modeling framework; Model evaluation.