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Evaluation of CCHE2D hydrodynamic and sediment transport model to simulate erosional sources in row crop agriculture in Midwest US

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Soil erosion due to rainfall and overland flow can be detrimental to agricultural management and long-term agricultural sustainability. Although numerous conservation measures and planning strategies have greatly reduced the amount of sediment moving within the landscape, there are still unresolved questions concerning initiation of particle motion, susceptibility to erosion, total soil loss, sediment transport and general measurement theory. Within agricultural fields, ephemeral erosion is particularly harmful because these sources can accelerate sediment transport, often yield more sediment than interrill sources and are more challenging to mitigate. In this study, terrain data were collected by aerial photogrammetry using an unmanned aerial system (UAS) following planting and approximately one month later, while climate variables during the period were collected using NexRad radar. Imagery was captured within seven agricultural fields (six in Iowa and one in Minnesota), ranging in size from 0.6 to 3.6 hectare (1.6 to 8.8 acre). Considering the small scale in topographic variation between two surveys, extreme efforts were applied to image processing and geospatial registration. Advanced models for camera calibration utilizing Micmac open-source photogrammetry software package were used to account for complex distortion patterns in the raw image data set. The undistorted images were then processed using Agisoft Photoscan for camera alignment, model georeferencing and dense point cloud generation (millions to billions of points per survey), from which digital elevation models (DEMs; 10 to 57 million cells) were produced. A physically-based finite element hydrodynamic and sediment transport model (CCHE2D, developed at the National Center for Computational Hydroscience and Engineering) was applied to simulate hydrological (runoff), sediment detachment (raindrop splash, sheet flow, and concentrated flow erosion) and sediment transport/deposition landscape evolution processes. Simulated geomorphological and sediment budget results over time were compared to field observations for model input parameter adjustment and consequently quantification of estimates. Integration of high-resolution spatial and temporal topographic measurements with physically-based numerical models support the development and validation of dynamic landscape evolution models needed for accurate prediction and quantification of gully initiation, evolution and impact on total soil loss and effective

conservation management planning.