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A remote sensing approach for evaluating regional-scale topsoil loss in the Midwestern United States

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Soil erosion in agricultural landscapes reduces crop yields and influences the global carbon cycle. However, the magnitude of historical topsoil loss remains poorly quantified at large, regional spatial scales, hindering predictions of economic losses to farmers and quantification of the role soil erosion plays in the carbon cycle. We focus on one of the world's most productive agricultural regions, the Corn Belt of the Midwestern United States and use a novel spectral remote sensing method to map areas of complete topsoil loss in agricultural fields. Using high-resolution satellite images and the association between topsoil loss and topographic curvature, we use high resolution LiDAR topographic data to scale-up soil loss predictions to $3.7x10^5$ km^2 of the Corn Belt. Our results indicate 34±12% of the region has completely lost topsoil as a result of agriculturally-accelerated erosion. Soil loss is most prevalent on convex slopes, and hilltops throughout the region are often completely denuded of topsoil indicating that tillage is a major driver of erosion, yet tillage erosion is not simulated in models used to assess soil loss trends in the U.S. We estimate that soil regenerative farming practices could restore 16±4.4 Pg of carbon to the exposed subsoil in the region. Soil regeneration would offset at least $2.5±0.3 billion in annual economic losses to farmers while generating a carbon sink equivalent to 8±3 years of U.S. CO_2 emissions, or ~14% of the global soil carbon lost since the advent of agriculture.