Geomorphic context for the Susquehanna Shale Hills Critical Zone Observatory: implications for the "age" of the critical zone and the sensitivity to climate and land use perturbations

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At the Susquehanna Shale Hills Critical Zone Observatory (SSHCZO), three study watersheds—Shale Hills, Garner Run and Cole Farm—reflect variations in lithology, base level, and land use. The sensitivity of the critical zone to perturbations in base level, climate, and land use thus varies from site to site. At Shale Hills (erosion rate = 20-30 m/Myr), the mobile regolith and topography are thought to reflect Holocene processes, whereas the sandstone catchment of Garner Run (erosion rate = 7 m/Myr) retains a signature of Pleistocene cold-climate conditions, resulting in contrasting chemical weathering profiles and sediment transport processes between the sites. At Cole Farm, we posit that the anthropogenic impact of farming drives spatial patterns in soil chemistry, regolith thickness and sediment transport. Ongoing work at Cole Farm using soil pits and coring will elucidate how short-term denudation related to agriculture compares to long-term landscape lowering, and the degree to which farming has mobilized and redistributed sediment. A planned coring campaign at nearby Bear Meadows will provide insight into how the biotic and abiotic features of the critical zone responded to climate change in the past, thus contextualizing modern observations. Additionally, shallow geophysical surveys provide insight into the spatial variability of subsurface architecture within each site. A key finding of geomorphic investigations at the SSHCZO is the understanding that localized conditions (lithologic, base level, and land use) result in landscapes with variable critical zone integration timescales, or "ages". This framework is crucial for cross-site interpretations as well as contextualizing observations made at larger geographic scales.