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Mitigating muddy flooding in a changing climate.

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Soil erosion by water and muddy flooding significantly threaten agricultural productivity and broader environmental health. This issue is widespread in the European Loess Belt, especially in Flanders, Belgium. The off-site impacts of muddy flooding – notably on water quality, ecosystems, and infrastructure – are catastrophic. Encouragingly, existing mitigation strategies that combine curative measures and farming practices have effectively managed soil loss and sediment transport. However, climate change is expected to greatly exacerbate these impacts, likely rendering existing mitigation measures insufficient. Despite a well-recognised need for adaptation, there is a continued lack of research dedicated to designing effective mitigation strategies for arable catchments facing an increased frequency and magnitude of muddy flood events in future. Our study explores adapting these measures for improved resilience to climate change, with a focus on a heavily impacted catchment in Limburg, Belgium. A modelling approach was used to predict future muddy flooding scenarios from 2021 to 2100, employing a novel methodology to select and downscale appropriate climate models for site-specific, daily resolution future climate scenarios. Soil erosion projections were generated using the WEPP model for four hillslopes under each climate scenario, while Erosion3D illustrated spatial erosion patterns across the catchment. Various likely land use choices and potential mitigation strategies under future climatic conditions were evaluated, with strategies shortlisted based on efficacy and farmer practicability. Our findings indicate a considerable increase in erosion magnitude and muddy flooding duration between 2041-2100 under current land management practices, with a marked increase in high-magnitude events. Conservation tillage emerged as the most effective strategy for 2021-2040, followed by no tillage for 2061-2080. Mixing summer crops with winter wheat is highly effective until 2080, but banning summer crops in vulnerable fields is necessary for 2081-2100. These findings underscore the need for better data – especially long-term muddy flood measurements – and enhanced public education on these issues, thereby offering insights applicable to other affected regions.