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What is needed to understand feedback mechanisms from agricultural and climate changes that can alter the hydrological system and the transport of sediments and agricultural chemicals?

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Modern agriculture activities are constantly changing as producers try to produce a crop, keep their soils fertile, control pests, and prevent contamination of air and water resources. Because most of the world's arable land is already in production we must become more efficient if we are to feed and clothe the world's growing population as well as do this in a sustainable manner; leaving a legacy of fertile soil and clean water resources for our descendants.
The objective of this paper is to demonstrate the importance of historical datasets and of developing new strategies to understand the effects of changing agricultural systems on the environment.
Scientists who study agriculture and its effects on water must constantly adapt their strategies and evaluate how changing agricultural activities impact the environment. As well as understand from historical datasets on hydrology and agriculture how a changing climate or agricultural activity such as a change in tillage method might impact the processes that determine the movement of agricultural chemicals off of the target site.
The 42.7 ha Hohrain (Rouffach, Alsace, France) vineyard experimental catchment offers several examples of how scientists have used historical data from this catchment to understand how the transport of agricultural chemicals may change due to a changing climate as well as how new strategies are developed for understanding the transport of agricultural chemicals.
Runoff is a major process of pesticide transport from agricultural land to downstream aquatic ecosystems. The impact of rainfall characteristics on the transport of runoff-related pesticides is crucial to understanding how to prevent or minimize their movement now, but also in understanding how climate change might affect runoff. If we understand how rainfall characteristics affect the transport of pesticides, we can use climate change models to predict how those characteristics might change in the future and be better prepared for those changes.
Recent analytical developments in the stable isotope analysis techniques have allowed the use of Cu isotopes as a tool to better understand the fate of copper in the environment. Copper (Cu) has long been used in agriculture mainly as a fungicide authorized in organic farming. Vineyards may become Cu-contaminated because large quantities of Cu are applied yearly (up to 6 kg ha^{-1} in the European Union) resulting in topsoil Cu concentrations in vineyards of 15 to 3200 mg/kg. Large amounts of Cu are removed from agricultural land by runoff and erosion, and this Cu may eventually contaminate aquatic ecosystems.
The stable isotopes of Cu (65Cu/63Cu) are potentially powerful geochemical tracers for transport and transformation processes of anthropogenic Cu. Proof of concept work is underway in the Rouffach catchment to determine if the stable isotopes of Cu can be useful in understanding how changes in hydrology affect the transport of metals.