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Mapping flood hazards and earthworm resilience under climate change

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Earthworms are adapted to resist extreme weather and soil flooding through a range of a physiological, behavioural and life-history strategies. During flooding, the oxygen content of soils reduces, representing a substantial risk to the survival of earthworms, which “breathe” oxygen across their skin. Therefore, changes in flood characteristics due to climate change are likely to pose significant challenges to earthworm populations. Given the importance of earthworms to several ecosystem services and provisions, understanding these risks is critical. Using historical (HadUK-Grid) data and future UKCP18 climate projections covering a 100-year period (1970-2080), we developed a rain-on-grid model for the whole of UK to model changing flood extent, frequency and duration due to changing climate conditions. The information was twinned with experimental data on earthworm survival under low oxygen conditions, including species-specific levels and oxygen affinities of their haemoglobins, mortality and cocoon viability to reveal a spatial understanding of hydrological extremes and its threats to earthworm under changing climate conditions.

Using the combined flood metrics, earthworm vulnerability and survival rate information, hazard maps reveal spatial and temporal hotspots of risk to earthworm populations and communities. These maps demonstrate critical thresholds beyond which earthworm populations experience mortality, threatening ecosystem resilience and ecosystem services. By linking hydrological extremes to earthworm response, this work provides an interdisciplinary workflow for predicting earthworm impacts due to changing flood characteristics under future climate.

The findings emphasise the need to integrate earthworms into flood risk management and ecosystem resilience planning, which can address potential ecosystem impacts that may be overlooked in climate adaptation strategies and promotion of nature-based solutions.