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HydroDARE: Detection and Attribution of Change in Hydrological Series

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What did the research aim to address?

HydroDARE, co-funded by Met Éireann, aimed to address a key knowledge gap in Irish climate adaptation: how to tell whether observed changes in floods, droughts and rainfall extremes are caused by human-driven climate change, natural variability, catchment change or data issues. This matters because flood risk management, water resource planning, agriculture, infrastructure design and local adaptation all depend on understanding why hydrological risk is changing. The project developed a practical, modular framework for detecting, attributing and scaling changes in hydrologically relevant series under real-world Irish data conditions. Its innovation was to use causal chains linking global warming to local rainfall, evaporative demand and river flow impacts, while explicitly considering uncertainty, internal catchment change, monitoring quality and natural variability. The framework was tested through four policy-relevant case studies covering seasonal rainfall extremes, Shannon floods, drought in Wexford and Storm Babet flooding in Midleton.

What did the research find?

The research found that human-driven climate change is already affecting important components of hydrological risk in Ireland. Long-term rainfall records show emerging climate change signals in flood-generating rainfall, including increasing winter and spring multi-day rainfall in western Ireland and increasing summer and autumn rainfall intensity in the south-east. In the Shannon catchment, observed increases in annual maximum flood flows are mainly climate driven, with peak flow sensitivity estimated at about 7.5–18.1% per 1°C of global warming, depending on catchment characteristics; arterial drainage may amplify this signal. For drought, no clear climate signal was detected in precipitation-only indicators, but warming-driven evaporative demand is already increasing drought severity. The Midleton case study showed how Storm Babet-type flooding could be stress-tested under further warming. Overall, the HydroDARE findings indicate that hydrological extremes in Ireland are already departing from assumptions of historical stationarity.

How can the research findings be used?

The findings can be used by the EPA, Office of Public Works, Met Éireann, local authorities, water managers and adaptation practitioners to move from assuming stationarity to monitoring, explaining and stress-testing changing hydrological risk. To support this transition, HydroDARE provides a transferable national framework for climate attribution in hydrology that can be applied across catchments, sectors and future adaptation assessments. The framework can inform flood risk assessment, drought monitoring, infrastructure design, catchment management, climate services and local or sectoral adaptation plans by identifying which variables carry a climate change signal and how they may scale with additional warming. Immediate next steps are to apply the framework more widely across Ireland, integrate flood-generating rainfall and evaporative-demand indicators into monitoring systems, and use event-based counterfactuals to test adaptation pathways, tipping points and design allowances. Implementation will require continued investment in long-term rainfall, temperature and flow monitoring, data rescue, quality assurance and metadata. Further work should extend the approach to ungauged catchments, compound events, heat, interactions with arterial drainage and methods such as UNSEEN to better represent rare but plausible extremes and natural variability.

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