

# Study exposes increasing flood risk in the UK

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Credit: Xi'an jiaotong-Liverpool University

As climate change continues to cause unpredictable and extreme weather events around the world, Xi'an Jiaotong-Liverpool University researchers are calling for engineers to rethink how they design for flood prevention.

In a recently published paper in the *Journal of Hydrology*, Ph.D. student Mengzhu Chen and Dean of Xi'an Jiaotong-Liverpool University's Design School, Dr. Konstantinos Papadikis, analyzed historical [flood](#) series and meteorological data from 158 catchment areas across the UK.

They found that flood series in most areas do not follow historical patterns. This finding directly challenges the use of a type of analysis that focuses on how often floods occurred in an area in the past. Flood frequency analysis has been the cornerstone of flood risk control, hydraulic structure design, and water resource management.

"Conventional methods for flood frequency analysis fail to take into account the volatile nature of floods caused by [climate change](#), human intervention, and land-use changes," Chen says.

"This is because the method uses the 'stationary assumption'—an assumption that relies on historical data to predict the frequency of floods and assumes that floods will occur within an unchanging range.

"In recent years, we have seen increased frequency of extreme weather, which has made the stationary assumption questionable. Our study demonstrates that in many parts of the UK, floods series are no longer following historical patterns, making it more unpredictable."

## **Avoiding disaster**

Chen says that if engineers or hydrologists continue to follow the traditional methods, it could lead to an underestimation of flood peaks with potentially catastrophic consequences.

"Continuing to base design and engineering on the stationary assumption could increase the risk of hydraulic structures and flood prevention measures failing as the infrastructure is not designed to withstand

additional—or more severe—flooding than predicted," she says.

"If we design structures to withstand 'one-in-100-year' floods but these extreme events are now happening three or four times in a decade, it would be disastrous.

"Water-related planning should always depend on the analysis of past data to inform projections of future conditions. But the present non-stationary conditions we see now means that the past data alone can no longer provide all the necessary information we need to understand the future statistical behavior of extreme precipitation and floods."

## **Multiple drivers**

The study evaluated various causes that may contribute to the non-stationarity of flood frequency. The results indicate that non-stationary behavior is more likely to be caused by a combination of multiple factors than a single element.

"While climate change plays a role in the non-stationarity of flood frequency, our research shows that the variability of rainfall regime remains the dominant driver for changes in flooding," Chen says.

"In the UK, the non-stationarity is also closely related with two atmospheric circulation patterns—the North Atlantic Oscillation and the East Atlantic Pattern."

## **Study adds understanding**

Despite a growing body of research, hydraulic engineering design and projects are still based on the traditional stationary assumption as there is no consensus on methods of analyzing flood frequency under a non-

stationary assumption.

Chen, who is based in XJTU's Department of Civil Engineering, says their study contributes to the understanding of flood behaviors in these increasingly common non-stationary environments.

"The current non-stationary modeling for floods is still in the early stage," she says.

"Although many new concepts and techniques for non-stationary flood frequency analysis are emerging, most of the existing studies are limited to the detection and diagnosis of apparent trends without investigating the underlying causal factors due to the high complexity of flood generating mechanisms. Our study provides new insights into these flood generating mechanisms, which is important for flood risk and water resources management. We need to adapt our approach to engineering to mitigate the impact of increasingly unpredictable and extreme flooding events."

The research paper "An investigation on the non-stationarity of flood frequency across the UK" is published in the *Journal of Hydrology*.

**More information:** Mengzhu Chen et al, An investigation on the non-stationarity of flood frequency across the UK, *Journal of Hydrology* (2021). [DOI: 10.1016/j.jhydrol.2021.126309](https://doi.org/10.1016/j.jhydrol.2021.126309)

Provided by Xi'an jiaotong-Liverpool University

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