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Implications of extreme floods for river ecosystems

The frequency and severity of flooding is expected to increase in the future. This study explored how these changes will affect rivers, in terms of structure as well as animal and plant life. The authors discuss the management implications of their findings and highlight areas for future research, including developing early warning systems for threats to ecosystems.

Changing patterns of precipitation and temperature are likely to make extreme weather events more commonplace. In some regions, the frequency, intensity, spatial coverage and duration of extreme floods is expected to increase, which could have serious effects on important natural habitats, such as rivers.

Floods have direct impacts on the organisms that inhabit rivers, displacing or killing freshwater wildlife for example. They also have indirect impacts on ecosystems via changes to the shape and form (geomorphology) of the river. The structure of rivers determines the quality and quantity of habitat that is available to freshwater organisms. Therefore, the structural changes caused by extreme flooding could influence river ecology even more than the direct impact of the flood itself, through changes to habitat availability for example.

Via a comprehensive literature review, researchers investigated the changes in river channels and floodplains that may occur due to extreme flooding, and how these will impact the local biota (plant and animal life). They first explored how changes in the frequency of large flood events might affect the geomorphology of riverine areas. They say geomorphic responses to extreme flooding can be catastrophic, resulting in large-scale transformation of river reaches, but differ depending on the river type. Possible effects include widening of channels and entrenchment, causing loss of habitat. Such effects might be more obvious in spring-fed streams than in monsoon-fed rivers.

In the past, extreme floods have had variable effects on river ecology, but studies show that animals and plants are generally resilient to flooding — unless it is accompanied by geomorphological changes. Freshwater life generally recovers rapidly from extreme flow events. However, if habitat is affected, recovery is much slower, if it takes place at all.

Not all changes are negative though. The physical force of a flood can expand or clear the floodplain, creating dry areas which provide crucial habitat for birds, reptiles, insects and plants. More frequent extreme flood events may therefore generate more habitat for certain organisms. If this floodplain habitat is not maintained, larger, more permanent species of plants and trees encroach from the surrounding land, and the habitat and species that live there will be lost.

As organisms react differently to flooding, the authors recommend development of a trait-based framework of species' responses to hydrological disturbance to help focus conservation efforts. Such a framework could be used to map species vulnerability in areas of the world where extreme flood events are predicted to increase and may provide early warning of when a species' habitat is threatened.

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Implications of extreme floods for river ecosystems *(continued)*

Infrastructure put in place to protect humans from severe flooding can also change the geomorphology, habitat quality and ecology of rivers. Dam construction, water removal and floodplain drainage all impact river communities, as they alter natural river behaviour and limit the connectivity that confers ecological resilience. Biodiversity often receives little or no consideration in engineering of this type, due to the large number of houses built on floodplains and pressure from the public.

Newer forms of flood prevention engineering that consider the natural form of rivers could mitigate biodiversity loss, and help to restore habitat and ecosystem function. The authors say Europe and in particular the Water Framework Directive (WFD) provides a good example of this, as it is focused on protecting river biota and flood mitigation through 'natural' approaches.

In total, the authors make 21 recommendations for future research on the effects of extreme floods on river biology. These include: establishing how extreme flood events shape river geomorphology and ecology (e.g. at what flood magnitude does geomorphology change?); developing tools to quantify geomorphology change; downscaling climate and hydrological models to the regional and catchment-scale; determining the threshold flood size from which recovery is not possible for certain species; and developing a species trait database to predict sensitivity to flooding. In terms of policy, they recommend more sustainable approaches to flood protection (as demonstrated by the WFD) which maintain the geomorphological complexity needed for biodiversity.