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Catchment Systems Engineering: an interventionist approach to manage floods, droughts and pollution at multiple scales

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Catchment hydrological function today is largely the product of human activity. They have been engineered and catchments now function in a less resilient way and are vulnerable to climate change. The negative impacts of some of this 'engineering' such as agriculture intensification and deforestation need to be addressed but the answer is not a simple matter of going back to nature. Nor is non-intervention an option. We propose a Catchment Systems Engineering (CSE) approach that incorporates and expands on existing approaches including Natural Flood Management, Green infrastructure, Sustainable Drainage Systems, Nature-Based Solutions and 'Working With Natural Processes' combined with traditional problem solving engineering, to provide a practical approach to improving catchment function. The approach is predicated on the need to take a holistic view of catchments and to make proactive interventions that provide system scale process improvements.

The CSE approach recognizes the need to understand how the catchment hydrological water balance has changed and what the impact is of those changes. The approach embodies how we can act to engineer catchment systems to a safer, functionally appropriate level.

Here, we set out the philosophy behind CSE, proposing a mitigation and adaptation approach for intensively exploited landscapes undergoing climate change. Altering attenuation capacity by holding water in catchments (attenuation) is the primary strategy underpinning CSE. The aim is to create infiltration zones, flood storage, sediment traps, wetlands, changing roughness, change flow pathway length and make best use of floodplains through managed inundation. A variety of methods that act at all scales are employed to change attenuation by adding new attenuation capacity to a catchment. These include features such as swales, bunds, ponds and grassy filters, buffer strips, ditches that hold water and trap top soil lost through erosion, small headwater floodplains that store water, wetlands and woodland. Here we address, at a catchment system level, the required degree of intervention and ask how, where, when and who should intervene? A series of examples are presented where these methods have been successfully applied to reduce flood and drought risk and provide multiple benefits from reduction of sediment and pollutant export to creation of habitats and recreation opportunities.