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Groundwater Flood Modelling in a Karst Environment

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A distinctive feature of lowland karst groundwater catchments located in the west of Ireland is the considerable degree of interaction between surface and groundwater; streams frequently disappear into underground fissures and conduits and then reappear again in surface reaches or as ephemeral lakes within glacially formed depressions. The study catchment covers an area of approximately 500 km2 in south Co. Galway on the western coast of Ireland and receives allogenic recharge through runoff from adjacent mountains and autogenic recharge from rainfall over the catchment. The entire catchment drains to a number of intertidal springs at Kinvara Bay via the karst limestone bedrock. During periods of sustained rainfall, the underground karst conduit system surcharges through a system of estavelles and floods low lying basins causing ephemeral lakes known as turloughs. These turloughs provide additional storage of groundwater not available within the limestone bedrock and thus act as a form of naturally occurring management mechanism for groundwater flooding. The catchment is unique as the natural flow system has not been heavily altered by land reclamation or arterial drainage schemes and has therefore been relatively unimpacted by human activities. The associated seasonal inundation cycle has led to the development of unique ecology within the normal upper and lower bounds of flooding providing a habitat for many floral and faunal species of national and international importance; many of these areas are therefore protected within the European Natura Network. The groundwater discharge zone from the catchment at Kinvara Bay also provides for a unique costal habitat and is also protected under European legislation.

The dramatic nature of the flooding associated with these turloughs has led to considerable groundwater flooding events in recent years beyond their established upper seasonal boundaries following exceptional rainfall events, causing considerable damage and disruption. An integrated 1D/2D pipe network model of the karst conduit system has been developed from an earlier 1D model to simulate the flooding mechanism of a series of these turloughs. Karst conduits were represented as pipes with links to a 2D mesh generated from high accuracy LiDAR data of the catchment allowing the flooding regime to be accurately simulated. The model was calibrated using historical stage data from a number of turloughs with aerial photography taken during recent flood events also used to inform and define flood extents. Groundwater flood mitigation measures have been simulated in order to identify whether solutions to such flooding can be developed which minimise impacts to the natural system hydrology and ecology but also protect properties and minimise disruption during extreme flood events.