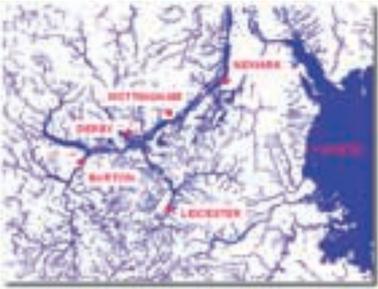


Floodplain management

Visualising floodplains through geological maps

by John Carney and Bruce Napier

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Distribution of floodplain alluvium in the East Midlands. Extracted from DiGMapGB (BGS digital geological map of Great Britain).

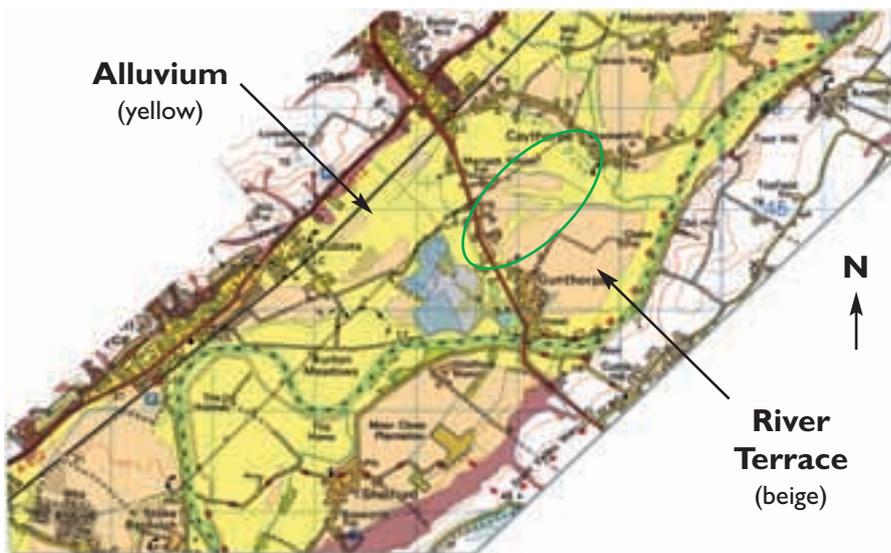
Floodplains are flattish valley floors that provide a natural conduit and temporary storage area for water during exceptionally high flows, when the capacity of the main river channel is exceeded. There have been abundant recent examples of how floodplains can pose a hazard to existing development, and there is currently a major debate over how best to ‘manage’ them in order to offset the future risk that they will present if predictions of increased winter precipitation are fulfilled. Typical questions being asked are: whether floodplains should be managed in a sustainable manner, in harmony with their environments, or whether their natural functions and processes should be modified in an effort to defend, at all costs, human development on floodplains? Underpinning these impending decisions is an increasing body of scientific information from a wide range of disciplines (such as climatology and hydrology), and this article explains how geology can also help.

Visualising the floodplains

The prevalent climate of concern over flooding risk and the plethora of initiatives that are being followed have only served to increase confusion over what floodplains actually are. Terms such as ‘flooding limit’ are often used synonymously with ‘floodplain’, an example being the government’s paper for England: *Development and Flood Risk* (Planning Policy Guidance Note 25). This maintains that the limits of floodplains cannot be defined precisely and states that floodplains ‘...are often delineated by the estimated peak water level of an appropriate flooding event’ (for instance a flood with a 1% annual exceedance limit, or 1-in-100-year return-period). The problem with this statistical approach is that any number of exceedance limits can be arbitrarily chosen, resulting in many separate ‘floodplains’ represented in a single river valley!

Geologists (and geomorphologists) would suggest that such estimations constitute flood-probability envelopes within the wider context of the natural floodplain. They see floodplains as landforms occupied by distinctive Quaternary deposits. These deposits have been systematically surveyed in the field and, as will be demonstrated, detected on remote images. The results of this work are the BGS maps (both digital and hard-copy), which are the country’s principal, and in most cases only, record of floodplain geology (*top left*).

In detail, geological maps show that the floodplain corresponds to the extent of alluvium, which represents the clay, silt, sand and gravel deposits laid down by fluvial activity (meander migration and flooding) related to the modern river channel (*left*). Boreholes can be useful for detecting alluvium in urban areas, and for elucidating its composition and physical properties at depth. Many larger floodplains include



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Simplified Quaternary geology of the River Trent floodplain around Gunthorpe, 9 km east of Nottingham. The oval area depicts the field of view shown in the photo top right.

additional areas of raised ground representing the ‘first terrace’ or the ‘floodplain terrace’, which is overlapped by the alluvium (*opposite, bottom*).

Geological maps therefore provide an important framework in which to consider the extent and effects of flooding. As the map (*opposite, bottom*) and photograph (*top right*) show, the areas represented by the first river terrace are, by virtue of their topography, flood-retardant.

Although the Environment Agency is currently upgrading its flood risk estimations for large floodplains such as the Trent, there remain many smaller floodplains within our drainage systems (*opposite, top*) for which this exercise may never be carried out. In those cases, the principal source of information for determining the likelihood of future flooding will be the geological map, perhaps in conjunction with other historical and anecdotal evidence.

Options for floodplain management

The flooding issue has stimulated much research into the scientific and societal aspects of floodplains in the UK, with organisations such as DEFRA and the Environment Agency playing a leading role in developing strategies to mitigate its effects. The options range from direct intervention (‘hard engineering’), such as the construction of flood banks (particularly in existing urban areas), the re-routing of the main channel and excavation of flood reservoirs, to more natural ‘soft’ measures such as improved farming practices, afforestation of the catchments, and ‘managed retreat’ — reversion to natural floodplain environments.

The ‘managed retreat’ option would involve the removal of artificial defences, such as flood embankments (*right*). This option aims to return to the floodplain its natural storage capabilities, reducing the eventual flood peak and mitigating the damaging effects of flooding downstream. It would create, or recreate, natural habitats and ecosystems, such as seasonal wetlands, which have all but disappeared from many embanked floodplain tracts ‘reclaimed’ for arable farming and other purposes.

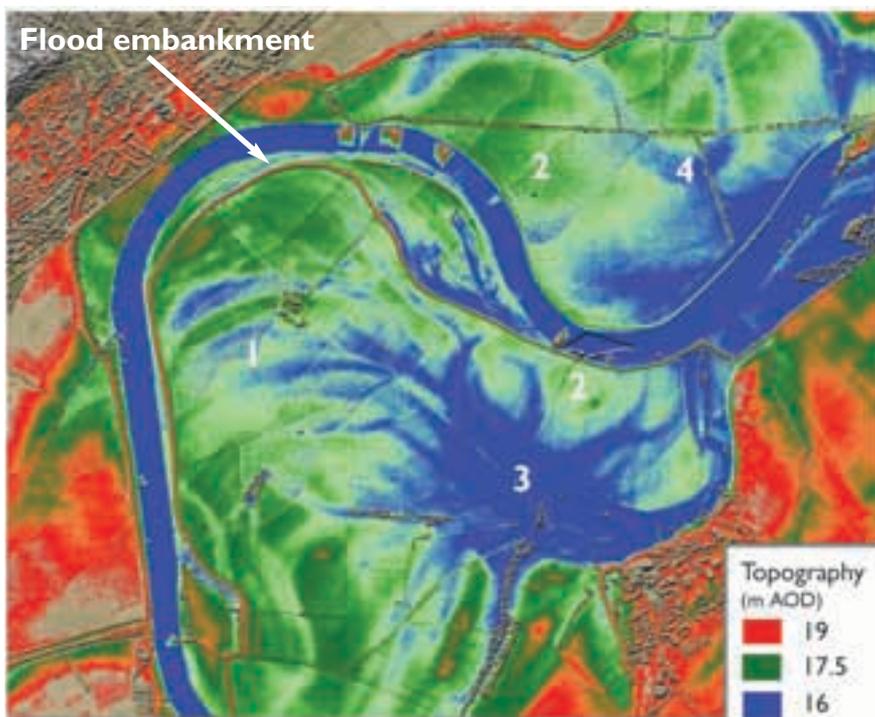
Trent valley flooding in November, 2000 (a 1-in-65-year magnitude event). The dry ground corresponds to river terrace outcrops on the geological map (opposite, bottom).



To adopt sustainable management scenarios, it will be necessary to assess the fluvial response of the river system at times of flood. More detailed information will therefore be needed, to complement the geological maps. High-resolution topographical surveying of alluvial tracts can reveal in spectacular fashion the modern fluvial structure of the floodplain, one of the outcomes (*below*) being predictive fluvial process-response models that will inform floodplain management decisions into the uncertain future of global climate change. ■

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Airborne laser scan (LiDAR method) showing micro-topography and alluvial elements of the Trent floodplain for the southern part of the area shown opposite (bottom). 1 Gravel ridges, caused by northward meander migration; 2 Levee; 3 Flood basin (potential wetland); 4 Abandoned channel. River flow direction is towards the north-east.

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