Measuring the contribution of groundwater and soil water to flooding

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Phase 1: Characterising the floodplain in 3D

Source: http://www.bgs.ac.uk/research/groundwater/catchment/Eddleston/home.html

Phase 2: Dynamic monitoring

Source: http://www.bgs.ac.uk/research/groundwater/catchment/Eddleston/home.html

Hill slope soil permeability

Measure soil K in paired grid areas within the hillslope and floodplain of grassland and forest areas

Site 1

Site 2

Site 3

Site 4

DW1: 500 yr old deciduous forest
DW2: 180 yr old deciduous forest
CW3: Conifer forest 45 yr old
FW4: 180 yr old Wetland woodland

Infiltration capacity

Old broadleaf woodland have 10-15 times higher permeability than soils under neighbouring coniferous forest and pasture land.

Soil K also related to parent geology

Soils on flood plain: low permeability

Groundwater - Baseline

River losing water to gw
Dominant gw flow along valley
Some older anoxic confined gw
Chemistry of shallow gw similar to river

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Floodplain groundwater: baseline

- Groundwater closely follows river and rainfall.

Flood plain groundwater: flood events

- Rising river levels propagate pressure effect within 2 hours.
- Fastest, greatest groundwater level response where confined.
- Groundwater levels close to river start to recede quickly after river level falls.

Interesting things in the detail ...

- Hillslope inflow causes slower & longer lasting groundwater level rise.
- Floodplain groundwater buffers hillslope runoff.
- Strongly influenced by antecedent conditions. Dry antecedent: impacts close to hillslope; wet antecedent: impacts across floodplain, including on river.

Groundwater and hillslope processes

- Available storage for excess rainfall in hillslope.
- Small inflow from hillslope to floodplain.
- River still generally losing to groundwater.
- Large inflow from hillslope to floodplain.
- Artesian groundwater: strongest close to hillslope.
- Groundwater discharge to river occurs once river level falls.

Groundwater levels close to hillslope continue to rise for up to 5 days.
Lessons learned

1. There is a strong relationship between soil permeability and land use – established deciduous forests most permeable
2. Groundwater across most of the floodplain, except near its edges, is more closely coupled to river flow than local rainfall
3. Groundwater at the edge of the floodplain is weakly coupled to river flows, but strongly connected to rainfall infiltrating on adjacent hillslopes
4. The combination of soil water storage on hillslopes and groundwater storage in floodplain aquifers acts as an important buffer to flooding