


British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Applied geoscience for our changing Earth

Measuring the contribution of groundwater and soil water to flooding

Alan MacDonald, Nicole Archer, Brigid Ó Dochartaigh



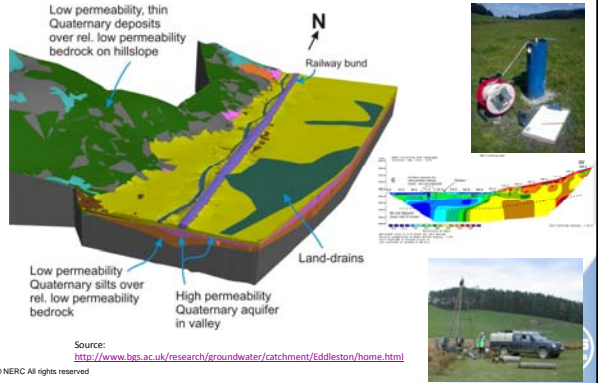
Funding:
Scottish Government
SEPA, BGS, U Dundee,
U W Australia

SFG: The Eddleston Water Project 30 Oct 2014

University of Dundee

© NERC All rights reserved

Phase 1: Characterising the floodplain in 3D



Low permeability, thin Quaternary deposits over rel. low permeability bedrock on hillslope

Low permeability Quaternary silts over rel. low permeability bedrock

High permeability Quaternary aquifer in valley

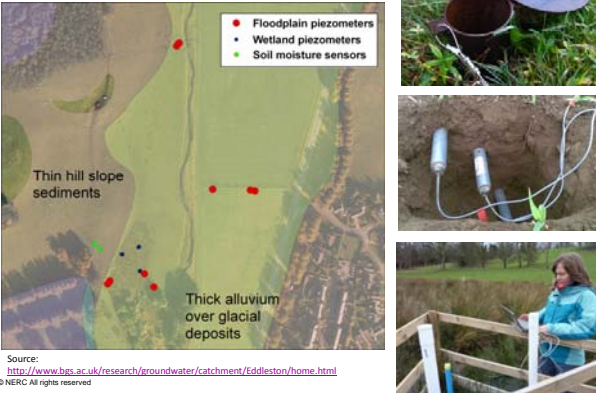
Railway bund

Land-drains

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

© NERC All rights reserved

Phase 2: Dynamic monitoring



● Floodplain piezometers
● Wetland piezometers
● Soil moisture sensors

Thin hill slope sediments

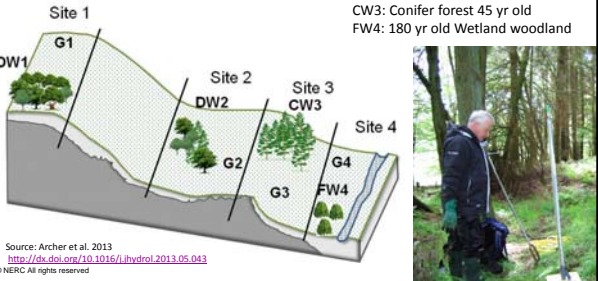
Thick alluvium over glacial deposits

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

© NERC All rights reserved

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

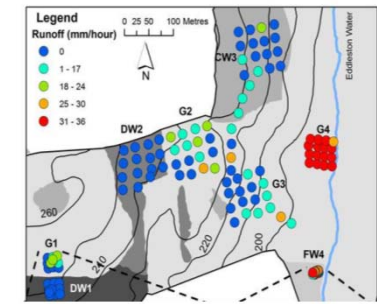
DW1
DW2
CW3
FW4

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

Source: Archer et al. 2013
<http://dx.doi.org/10.1016/j.jhydrol.2013.05.043>

© NERC All rights reserved

Infiltration capacity



Legend
Runoff (mm/hour)

- 0
- 1 - 17
- 18 - 24
- 25 - 30
- 31 - 36

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

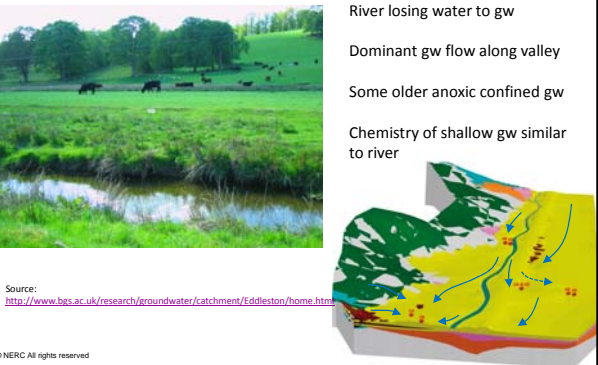
Soils on flood plain: low permeability

Runoff from a 1 in 10 rainfall event

Source: Archer et al. 2013
<http://dx.doi.org/10.1016/j.jhydrol.2013.05.043>

© NERC All rights reserved

Groundwater - Baseline



River losing water to gw

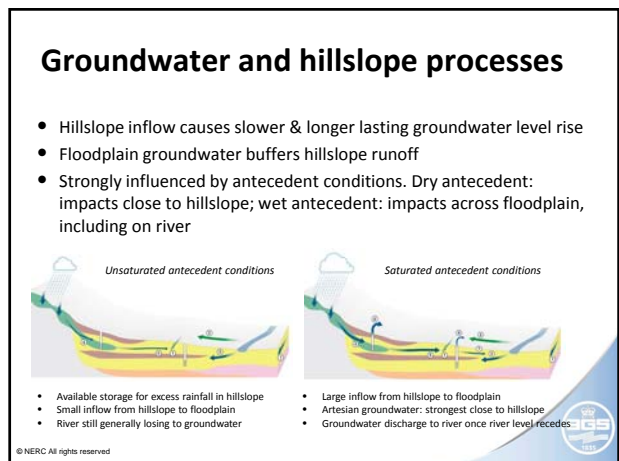
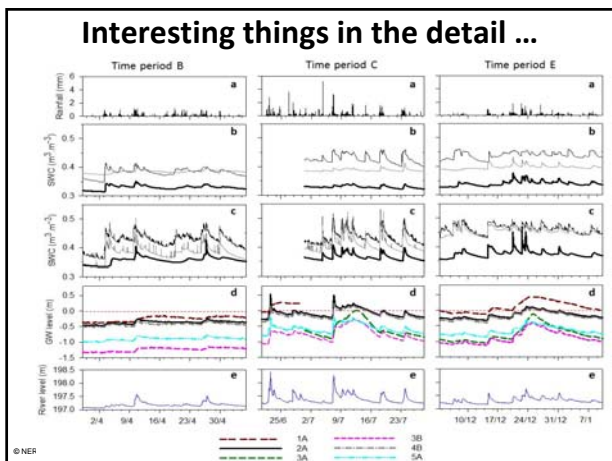
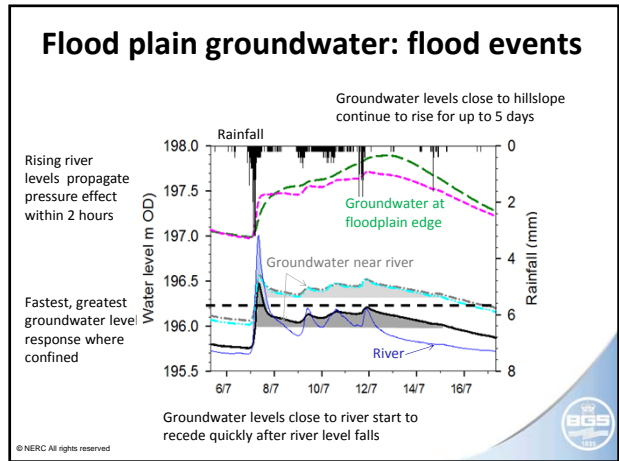
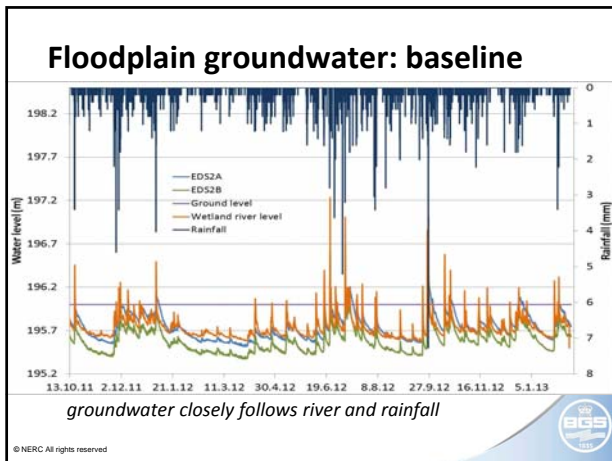
Dominant gw flow along valley

Some older anoxic confined gw

Chemistry of shallow gw similar to river

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

© NERC All rights reserved



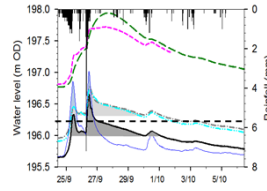
Lessons learned

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



© NERC All rights reserved

Still learning !



© NERC All rights reserved

