

Is there a link between soil compaction and flooding?

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Soil conditions & flooding: Linkages

- **The Source:**

Soil: The hydrological regulation function.

- **The Pathway:**

Transfer from the field / hillslope to:

- **The Receptor:**

The surface water network?

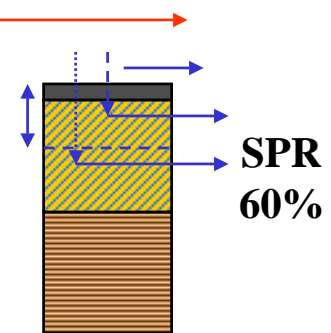
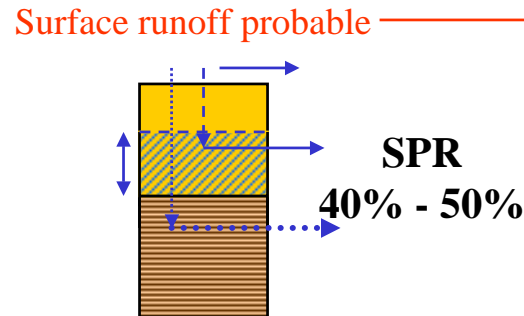
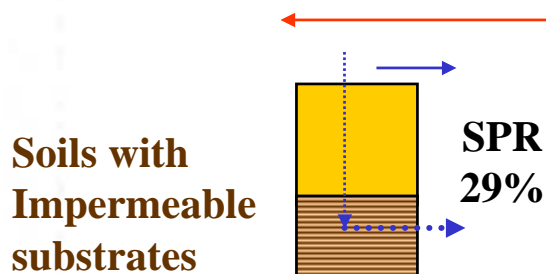
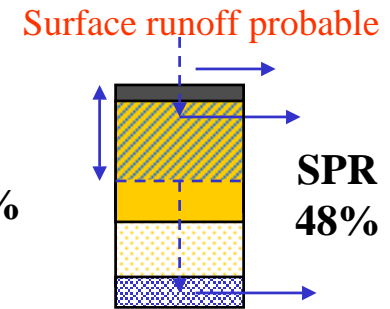
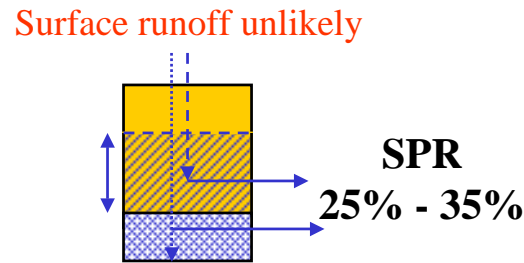
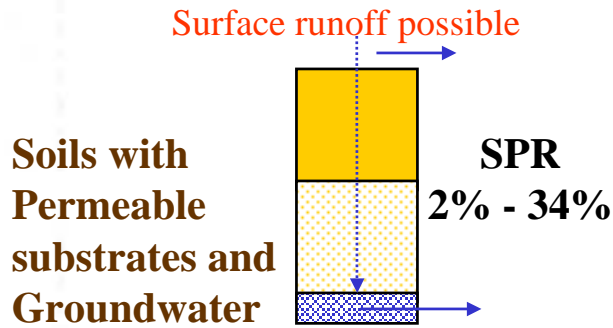
The Hydrological Regulation Function

- Storage
- Transmission of excess water

Inherent differences between soil types:
Some soils have greater storage potential than others.

Soils with small storage potential transmit excess water rapidly – greater short term stream response to rainfall.

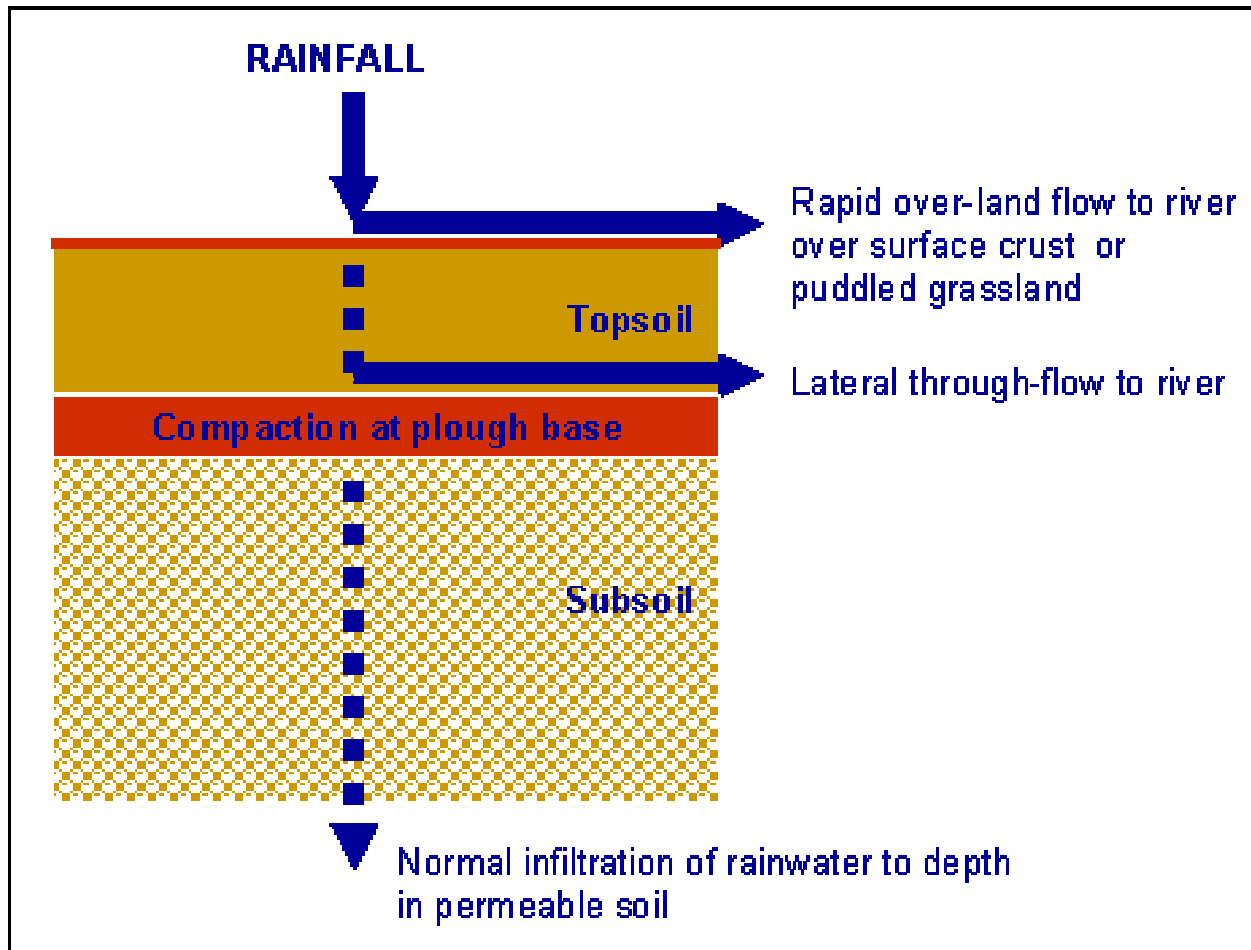
Hydrology of Soil Types (HOST)



Land Management modifies the hydrological regulation function

- Land Drainage practices alter the natural soil water regime.
Forest systems; Arable systems; Grassland systems.
- Practices which keep bare surfaces on inherently weakly structured sandy and silty soils that are susceptible to **crusting and compaction**.
Autumn sown crops; Late-harvested crops; Orchards; Winter vegetables.
- Practices which require access to land when the soil hydrological cycle is at or approaching its wettest period cause **compaction**, especially on soils with impeded drainage.
Autumn-sown crops; Late-harvested crops; Winter vegetables; Livestock rearing.

Impacts of Soil Structural Degradation



The Source: Summary

- Impacts of various land management practices in increasing in-field and hill-slope runoff is well known and documented. BUT effects are seasonal and very variable from year to year.
- Evidence for the extent of soil structural problems related to specific management practices is accumulating:
 - SW England:
11 Catchments in Cornwall, Devon, Somerset and Hampshire (2002 – 05).
 - SE England:
2 catchments (Uck & Bourne). (2000/01, 02/03. South Downs (Boardman).
Severn (2000/01). Pont Bren catchment (2005).
 - Yorks. Ouse (2000/01).

Up to 30-40% of total land in catchments may be affected.
- Good evidence that specific management mitigation practices significantly reduce in-field and hill-slope runoff.

The Pathway

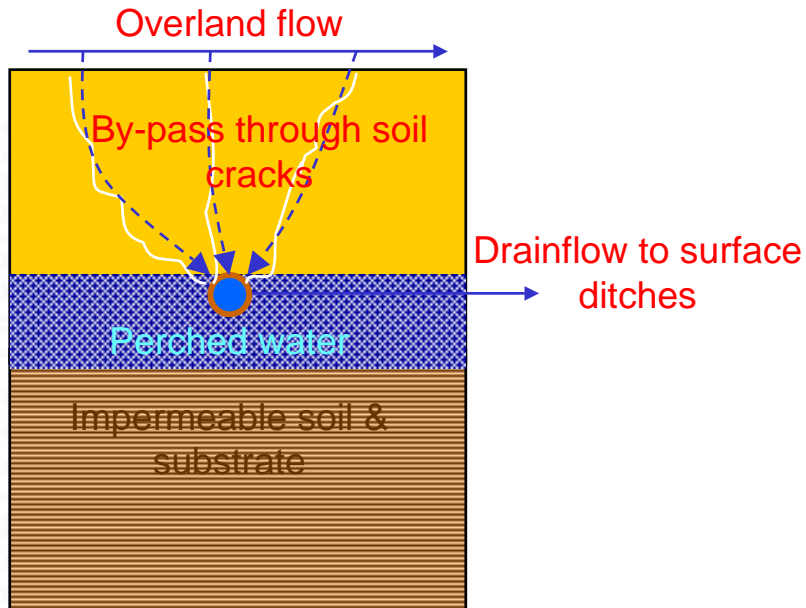
- Transfer from the field and/or hillslope to the surface water network.
- Three principal routes:
 - Overland flow. **Rapid.**
 - Interflow through the soil. **Rapid.**
 - Interflow through the soil and substrate to groundwater. **Intermediate.**

Overland Flow



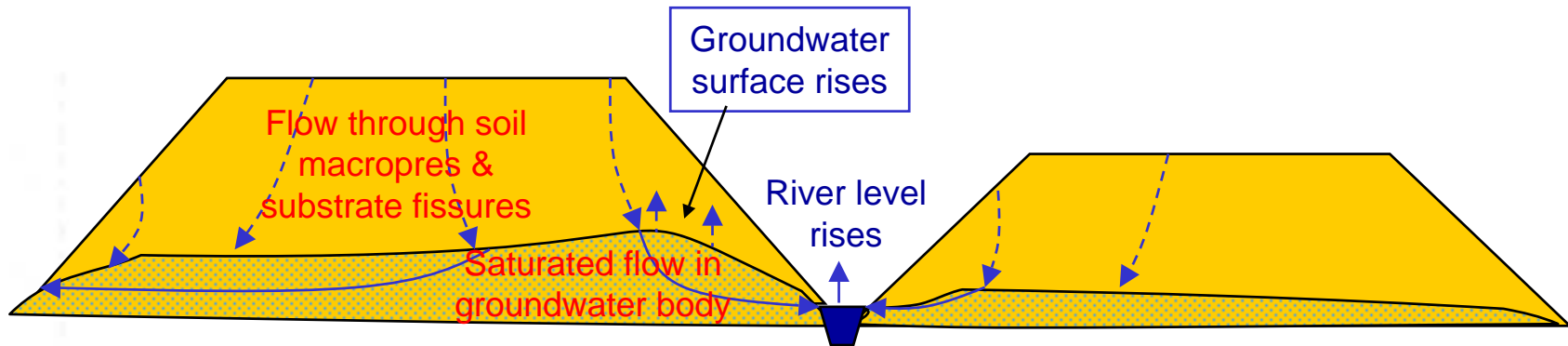
- Depends on the connectivity of surface pathways to the receptor.
- Very variable according to local topography and human infrastructure.

Interflow through the soil



- Depends on the soil type and type of field drainage.
- Very variable according to crop and season.

Interflow to groundwater



- Depends on the type of soil & substrate.
- Very variable according to the extent of fissuring and connectivity between soil and substrate.

The Receptor

- With respect to soil conditions and flooding, there are two different types of receptor:
- The surface water network.
 - 'Out of bank' flooding: Large streams and rivers overflow onto adjacent low-lying areas.
- The overland surface pathway.
 - Local 'flash-' or 'muddy-' floods generated via surface run-off and channelling of flows through the landscape.
- The two types are often linked but there is evidence from Belgium that rainfall events causing local flash or muddy floods are not always associated with out-of bank flooding

The Possible linkage - 1



- A flash- or muddy-flood is generated. May cause local damage.
- If large enough or there are many in the catchment

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The Possible linkage - 2

- Run-off is transferred to the stream network and down-river



The Possible linkage - 3

- Where, often compounded by other types of runoff, it results in out-of-bank flooding.



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Evidence for the linkage

- Review of the impacts of rural land use and management on flood generation. (O'Connell *et al*, 2004: <http://www2.defra.gov.uk/research/>)
- Good evidence from the UK, northern France, Belgium & Netherlands that specific arable management practices result in localised, seasonal & damaging muddy floods. Also UK evidence that specific changes in management practices can significantly reduce the frequency of such floods (Boardman *et al*).
- BUT:
Direct evidence that management practices which cause soil structural problems affect 'out-of-bank' flooding is lacking at present.

Reasons for the lack of evidence

- Very few studies carried out with the direct aim of identifying an impact of management-induced soil structural problems on flooding.
- National studies of trends in annual maximum flood records are dominated by year to year climatic variation (impact of changes in land use & management difficult to identify).
- Individual catchment studies limited in scope and/or available data.
- Interaction between the soil, topographic, land management and human infrastructure variables that control the generation of storm runoff and its transfer and conversion to out-of bank flooding are complex and spatially variable.

Conclusions

- Significant evidence for increased source runoff related to soil structural problems and associated local muddy floods contrasts with the very limited evidence for related 'out-of-bank' flooding.
- This represent a significant knowledge gap that requires addressing.
- The complexities of the linkages mean that systematic and targeted catchment level studies are required.
- All efforts to improve soil structural problems within catchments will have environmental benefits BUT we should not expect all such improvements to result in reduced 'out-of bank' flood risk.
- Expertise from both the water and soil communities is