NFM Programme Finale
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LANDWISE NFM

LANDWISE field surveys:
How land use and soil management affects soil properties, with implications for flood risk

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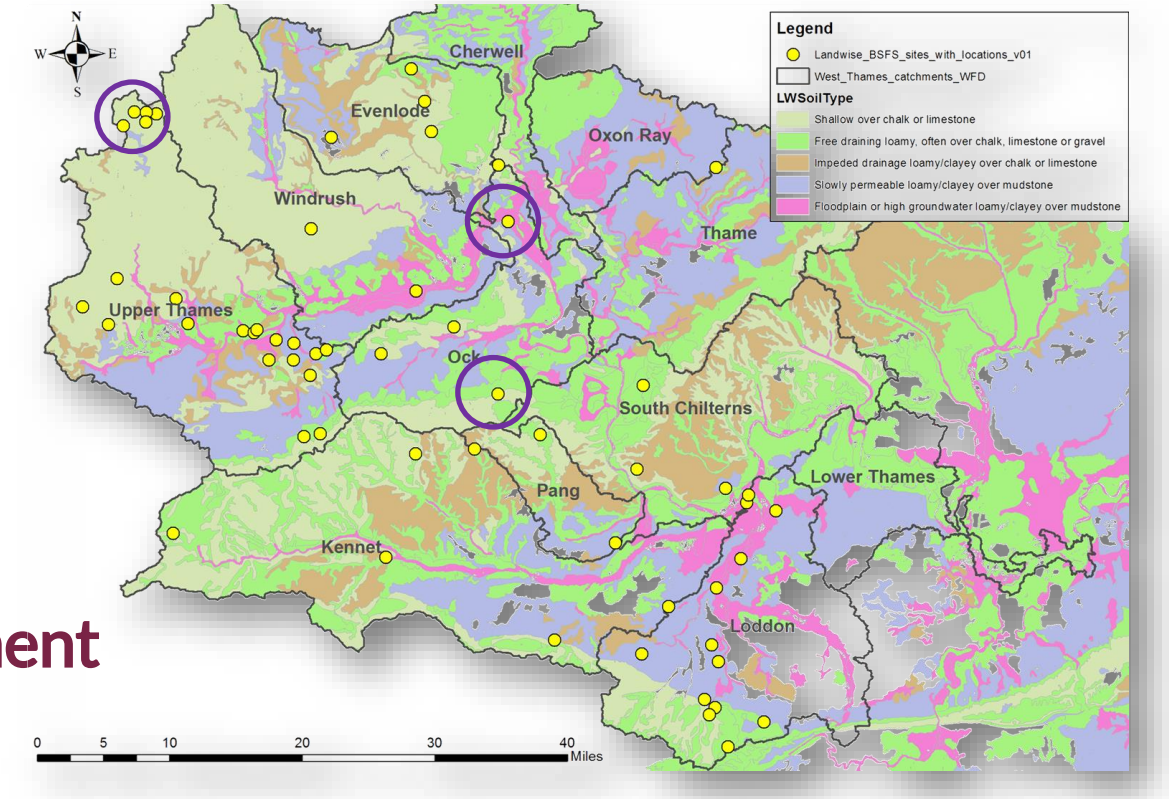
Field Survey Overview



Measure soil physical properties (+ land use/management questionnaire)

Measure soil hydrological / hydraulic properties

Broad-scale survey of 164 fields

- Measure **properties of soil** that influence storage of water below ground: *bulk density (porosity), texture, structure, organic matter (+ water content, + vegetation).*
- Focus on **soil surface** (top 50 mm)

Detailed survey of 3 locations (7 fields)

- Measure **properties of soil, infiltration** and **water storage** over time: *infiltration, hydraulic conductivity, soil moisture retention as well as bulk density, organic matter*
- Measure changes in **soil water** across larger areas and with depth

Field survey sampling

Broad-scale Survey: 164 fields with 5 soil types and 4 land uses

Geology	LANDWISE Soil Type	Land use and management			
		Arable		Grassland (permanent, est. 5+ yr.)	Woodland (broadleaf, mature)
		Rotation with grass*	Rotation without grass		
Carbonate (Chalk, Limestone)	Shallow over chalk or limestone	8 + 6	9 + 1	8	8
	Free draining loamy [1]	9 + 1	8 + 1	8	8
	Impeded drainage loamy/clayey	4	9	8	8
Mudstone	Slowly permeable loamy/clayey	8	8	8	8 + 1
	Floodplain or high groundwater loamy/clayey	4	7	8	8

* incl. grass only rotation (e.g. dairy), not just grass as break crop

[1] sometimes also over gravel superficial deposits overlying mudstone

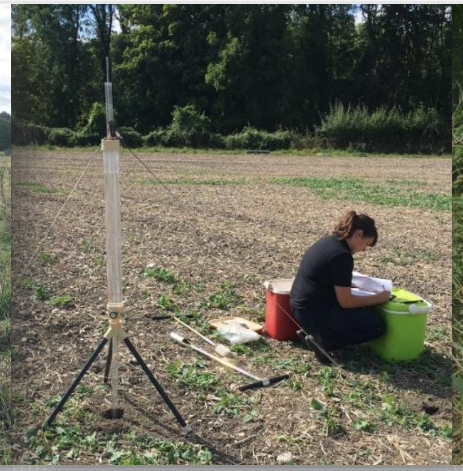
Detailed Survey

- 3 arable fields with herbal ley, rye & clover and no grass on shallow soils over limestone.
- Controlled and conventional traffic arable on medium soils over chalk.
- Broadleaf woodland compared to permanent grass on heavy soil over mudstone.

Field survey – example measurements

Broad-scale Survey

Visual Estimation of Soil Structure.
Surface soil sample for analysis of soil moisture and bulk density (BD), aggregate stability, organic matter (OM), hand texture and laser particle size.



Detailed Survey

BD and OM at 5 depths to 1m
Soil saturated hydraulic conductivity (*Ksat*) at 2 depths
Surface infiltration rate
Soil and vegetation root depth

Broad-scale field survey – example field observations

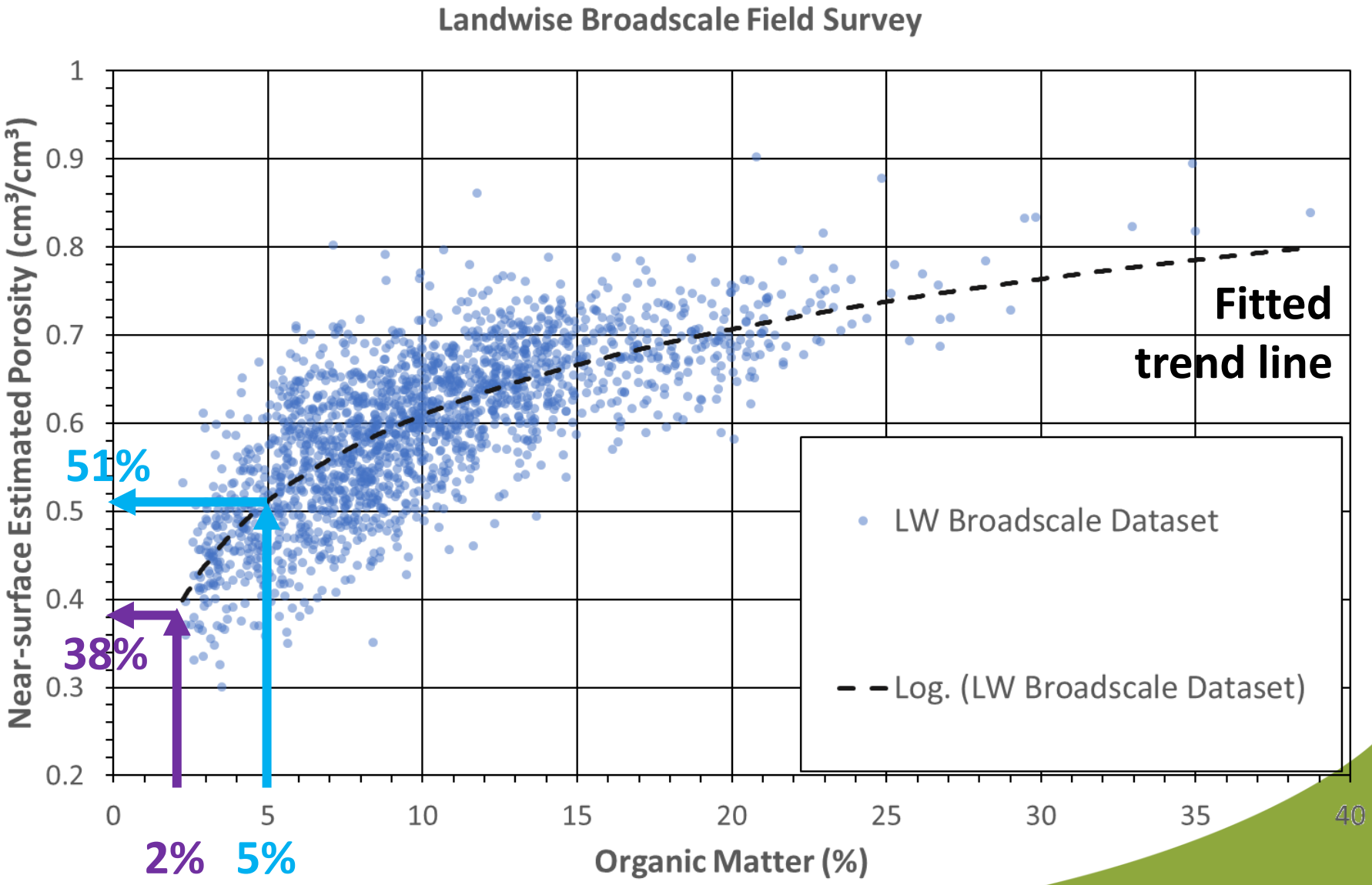
- Importance of soil surface condition - January 2020 (River Loddon catchment)
- Heavy clay soil
- Very near-surface saturated - water rapidly ponds and runs off, but deeper soil remains unsaturated (red arrow)

Broad-scale field survey – soil porosity

- Q: How much water can the soil hold (porosity)?
- Soil porosity estimated from measured bulk density (BD) data using:
  - soil mineral particle and organic matter typical densities (~2.65 and ~1.25 g/cm^3 respectively) and relative proportions
  - clay soils typically have higher porosity (lower BD) whilst sandy soils typically have lower porosity (higher BD)
  - related to soil particle shape and packing
  - excluding shrink/swell effects (some clay soils)
- Q: How can we increase porosity (to reduce flood risk and provide more water for crops)?

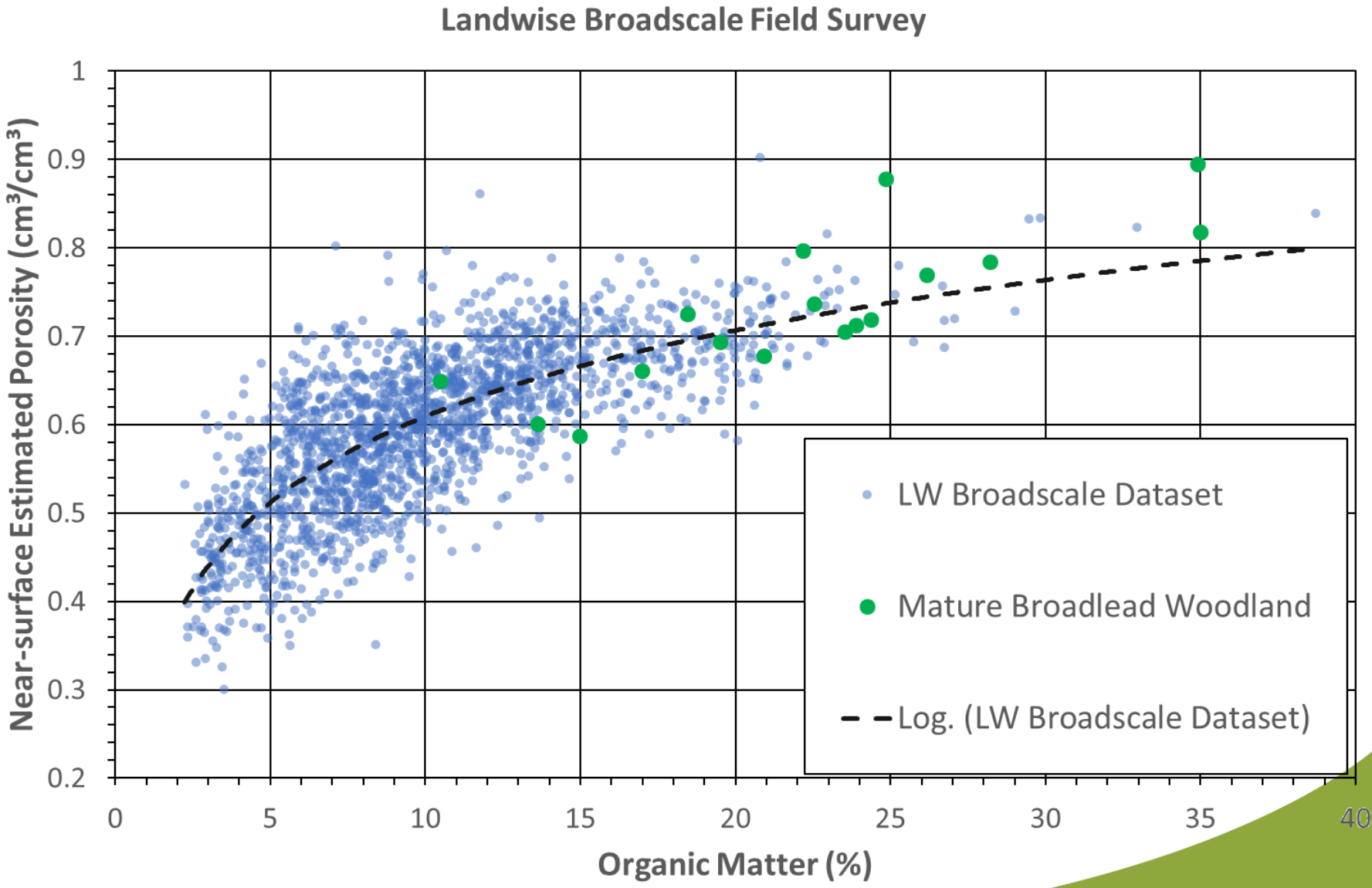
Broad-scale field survey – soil porosity & organic matter

- Increasing soil organic matter content increases soil porosity
- Points represent full range of field conditions (infield, trafficked and margin)
- If organic matter is 'low' (1-2%) to 'medium' (2-4%), modest increases can significantly increase porosity



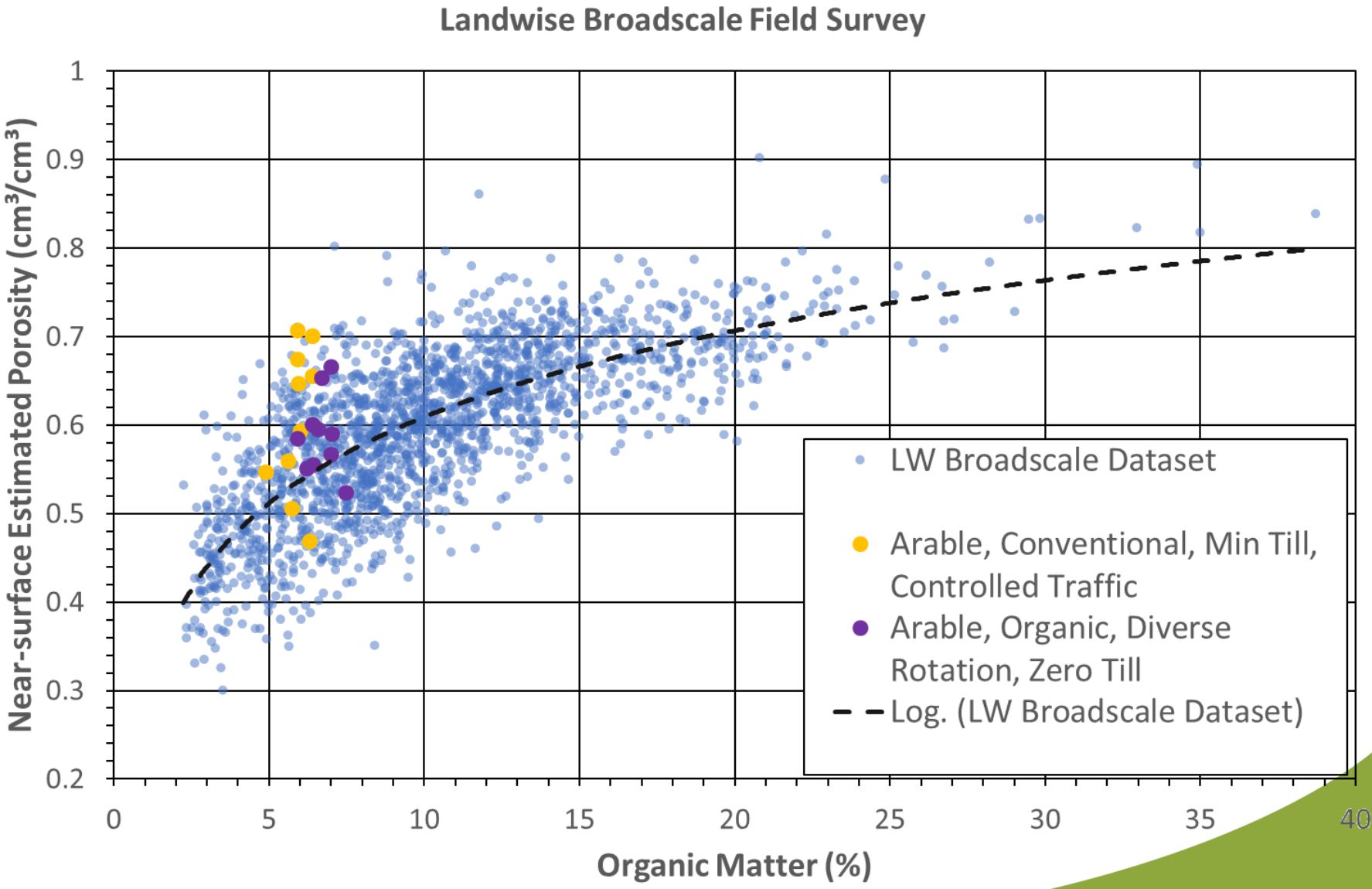
Broad-scale field survey – soil porosity & organic matter

- Land use and management practices can have a significant impact on soil porosity
- Mature broadleaf woodland results in high soil porosity
- Example points show typical woodland conditions (on farms) over a range of soil types



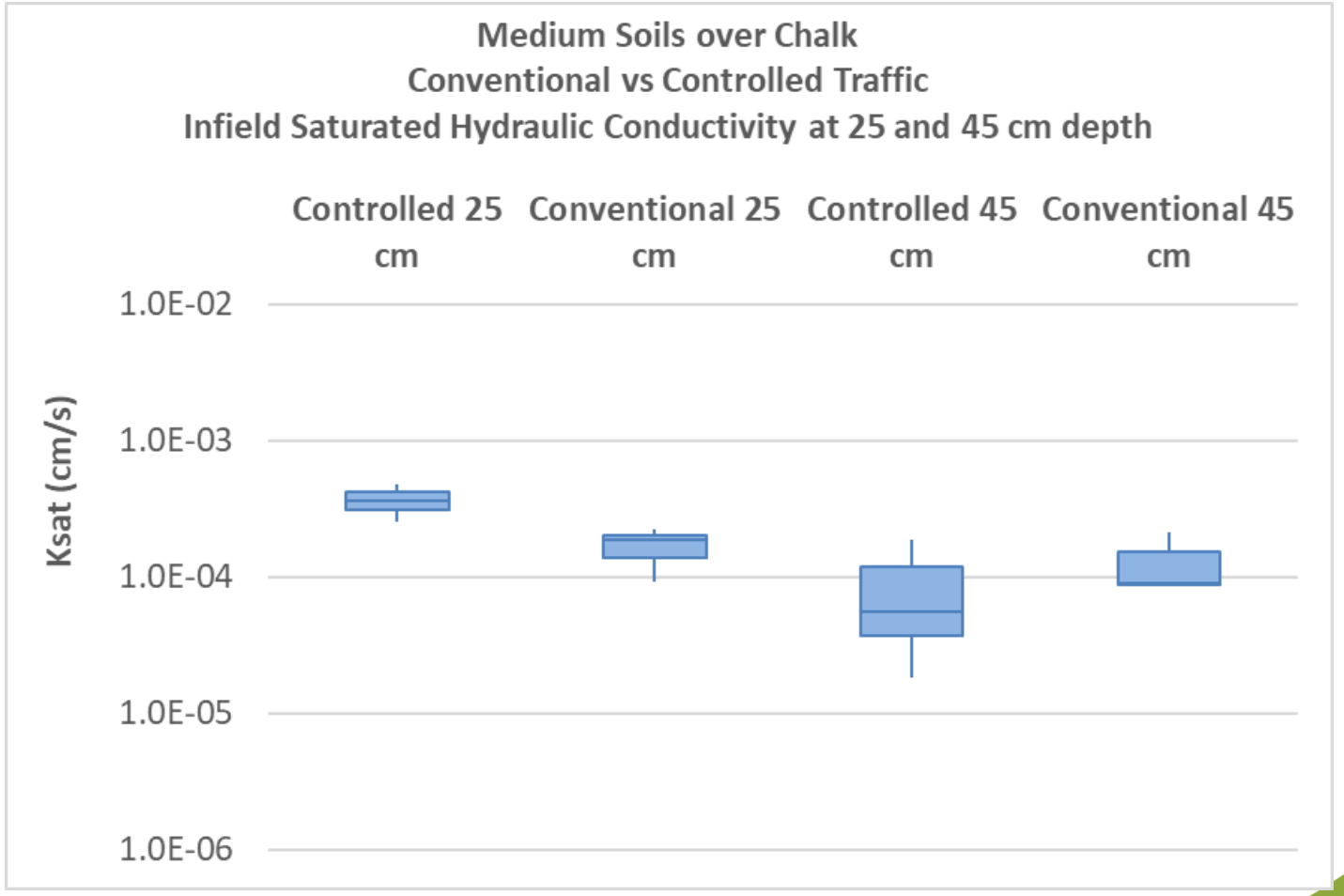
Broad-scale field survey – soil porosity & organic matter

- Land use and management practices can have a significant impact on soil porosity
- Innovative conventional and organic farming practices can result in high soil porosity
- Example points represent general infield and trafficked field conditions



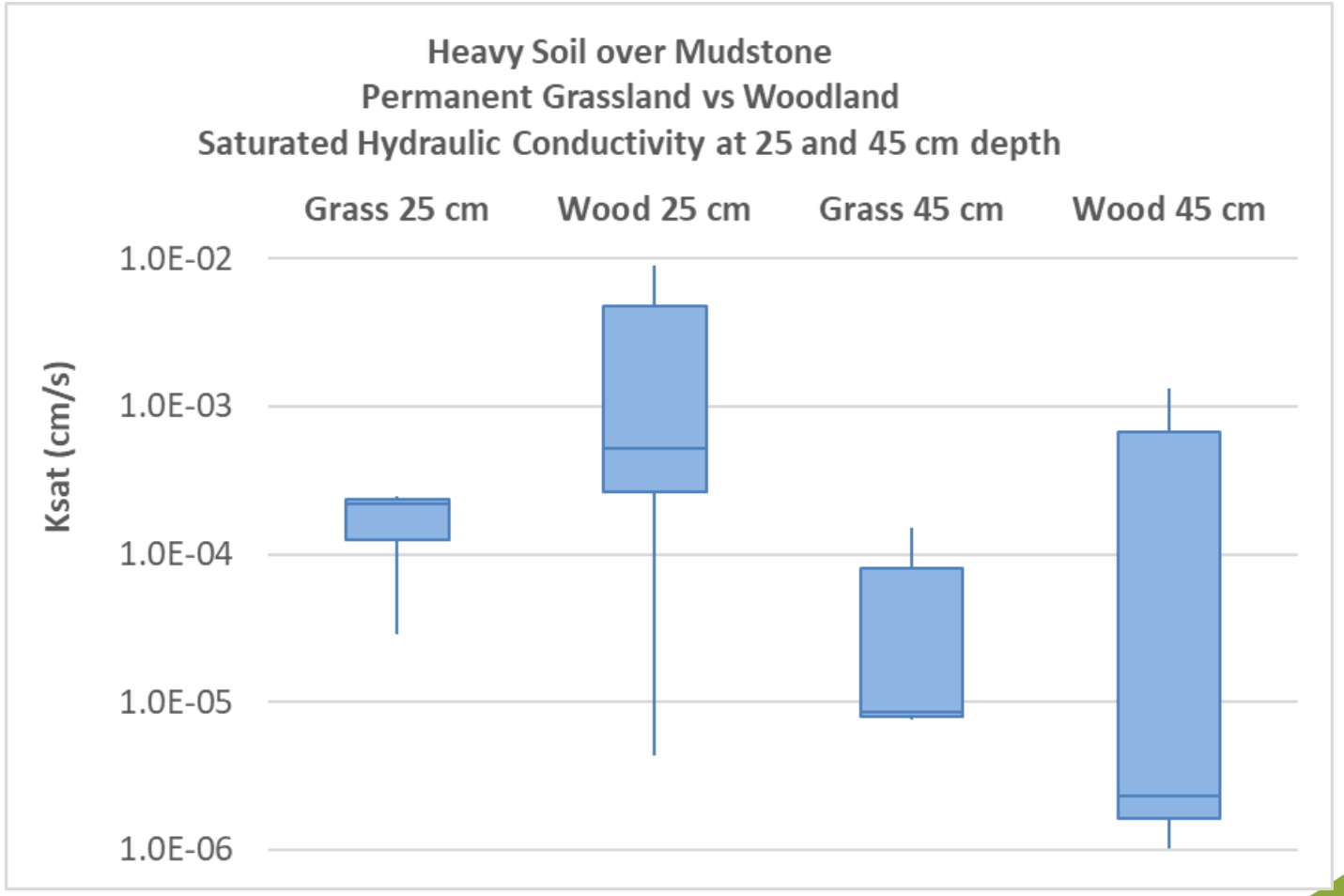
Detailed field survey - soil water: innovative farming

- Infield *Ksat* greater at 25 cm soil depth under controlled traffic arable (+ min till, cover crops), compared to more conventional arable (min till, grass in rotation - ploughed)
- Higher *Ksat* will increase infiltration into, and percolation through soil, reducing surface runoff and associated flood risk
- *Ksat* decreases at 45 cm depth for both controlled and conventional management (increased consolidation and higher bulk density at depth)



Detailed field survey - soil water: grassland vs woodland

- *Ksat* higher in mature broadleaf woodland relative to permanent grassland
- Higher *Ksat* will increase infiltration into, and percolation through soil, reducing surface runoff and associated flood risk
- As in arable fields, lower *Ksat* at 45 cm depth for both grassland and woodland.
- Greater variability in woodland soil structure and resultant *Ksat*.



Summary of findings so far…

- Land use and management can significantly enhance soil physical and hydrological/hydraulic properties and flood mitigation potential.
- Soil management important – improve near-surface soil properties and reduce preferential flow pathways to increase infiltration of rainfall into soil and reduce runoff.
- Increasing organic matter content increases soil porosity, creating more soil water storage and potential to mitigate flooding.
- Fields with 'low' starting organic matter content can greatly improve soil porosity therefore soil water storage with relatively modest organic matter increases.
- Organic additions are not the only way to improve soil structure, innovative arable management practices (e.g. controlled traffic and min till) also improve soil structure, increase saturated hydraulic conductivity and therefore NFM potential.
- Mature broadleaf woodland has the highest organic matter content, soil porosity, saturated hydraulic conductivity and NFM potential relative to arable and grassland.
- Further analysis and quantification ongoing…

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Thank you!

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