Energy crops: implications for the UK's groundwater resources

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Outline of talk

- What are energy crops?
- The implications for water quality
- The implications for water quantity
- Where will these crops be grown?
- Conclusions

What are energy crops ?

- Energy crops are those crops grown as feedstocks for energy production;
- Currently, food crops are also used as energy crops - using the seed as a feedstock for biofuels and/or the residues for heating and power;
- Biomass crops are grown specifically for energy production and produce high yields of ligno-cellulosic material;
- Currently, biomass crops are used as a feedstock for generating heat and/or electricity;
- In the future they will also be used as feedstocks for producing "second generation" biofuels.
- Currently about 15,000 ha planted in England (cf. crops account for about 3,700,000 ha)
- "the potential to use up to a further 350,000 hectares across the UK by 2020" – *UK Biomass Strategy, 2007*

Short rotation coppice (SRC) willow

- Coppiced to promote development of many stems;
- Uses the C3 pathway for photosynthesis;
- Tall (up to 8 m);
- Deeper rooting cf. food crops (up to 1.5 m);
- Perennial with an economic lifetime of over 20 years;
- Low inputs of fertiliser, herbicides and pesticides;
- Usually harvested on a 3 year cycle – mid Oct. to Mar.

Miscanthus x giganteous

- Rhizomatous, semi-tropical grass;
- Uses the C4 pathway for photosynthesis – but it is cold tolerant;
- Tall (up to 3.5 m) and dense canopy - efficient at intercepting light;
- Deep rooting cf. food crops (up to 2 m);
- Perennial with an economic lifetime of over 20 years;
- Lows inputs of herbicides, minimal applications of fertilisers and pesticides;
- Harvested annually – Feb. to Mar.

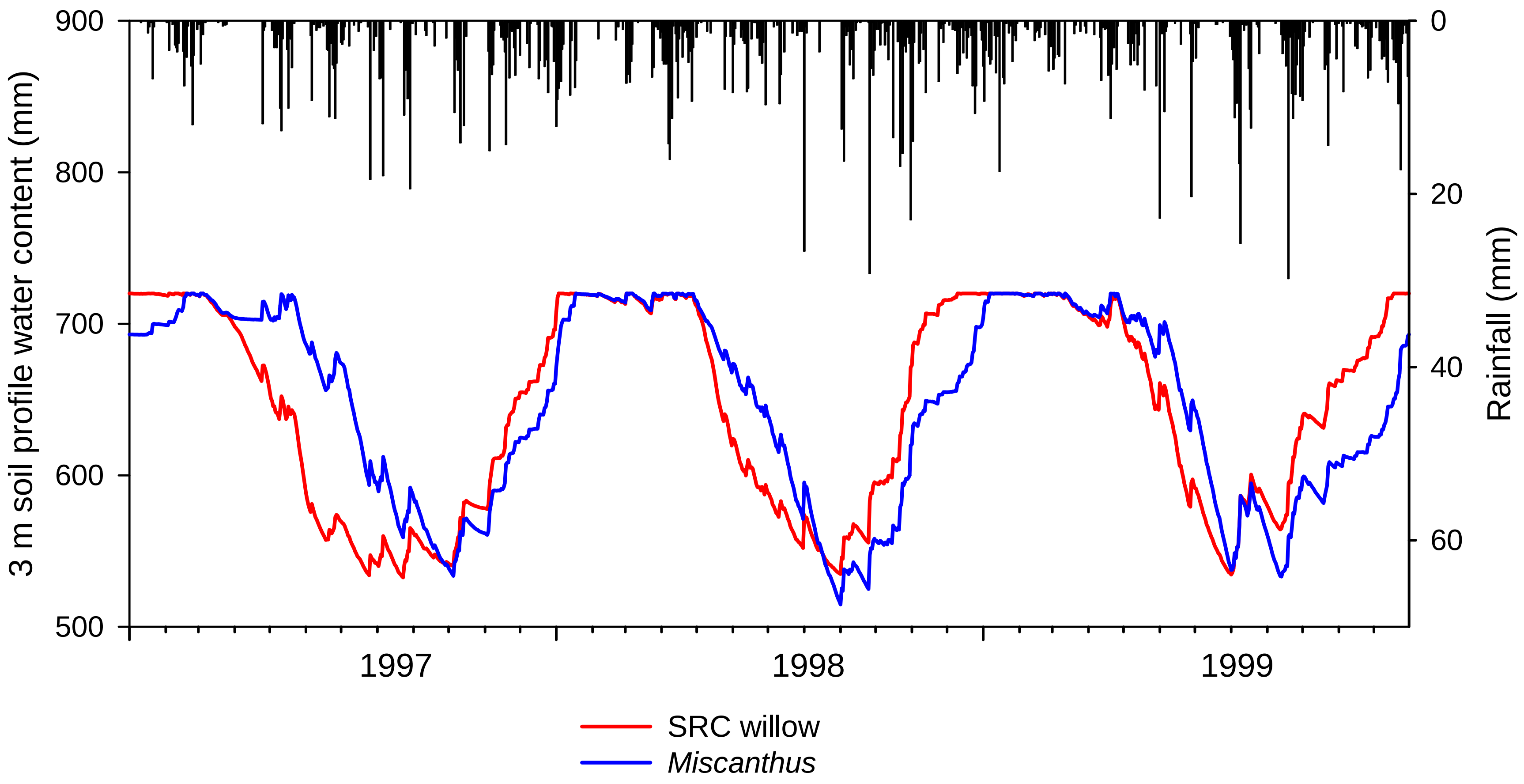
Water Quality

- Little published evidence on pesticides and herbicides but likely to be positive due to the low inputs;
- There have been some studies for N-fertilisers:
  - They are low value crops so “normal” agricultural N fertilisers are not used after establishment
  - SRC Willow:
    - Appears to need low inputs of N after harvest
    - N-leaching 30-50% lower than in cereal production
  - Miscanthus:
    - Research shows very variable response of yield to N
    - Recent results suggest N-fixation may be occurring
- However, P and K are still needed.
- Impacts on sediment transport is very variable.

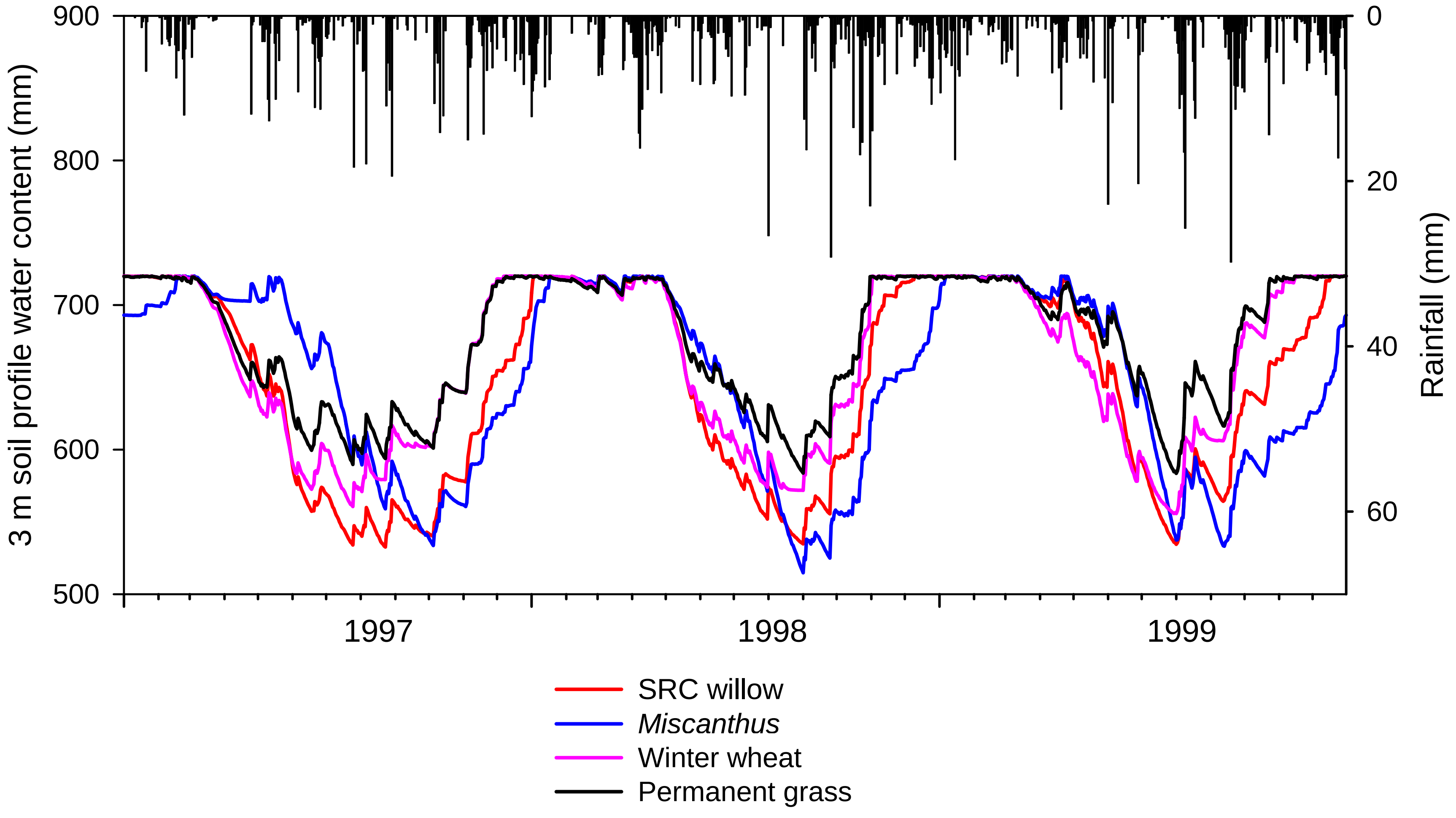
Water Quantity

- Both crops are deep rooting cf. agricultural crops so transpiration rates are less susceptible to soil water availability.
- SRC willow has a taller and rougher canopy so interception losses are slightly higher than conventional crops.
- *Miscanthus* uses the C4 photosynthetic pathway and so should be more water efficient, plus it has a shorter growing season.
- But the variety commonly grown loses its leaves slowly through the winter so interception losses are higher.

Simulated soil water contents



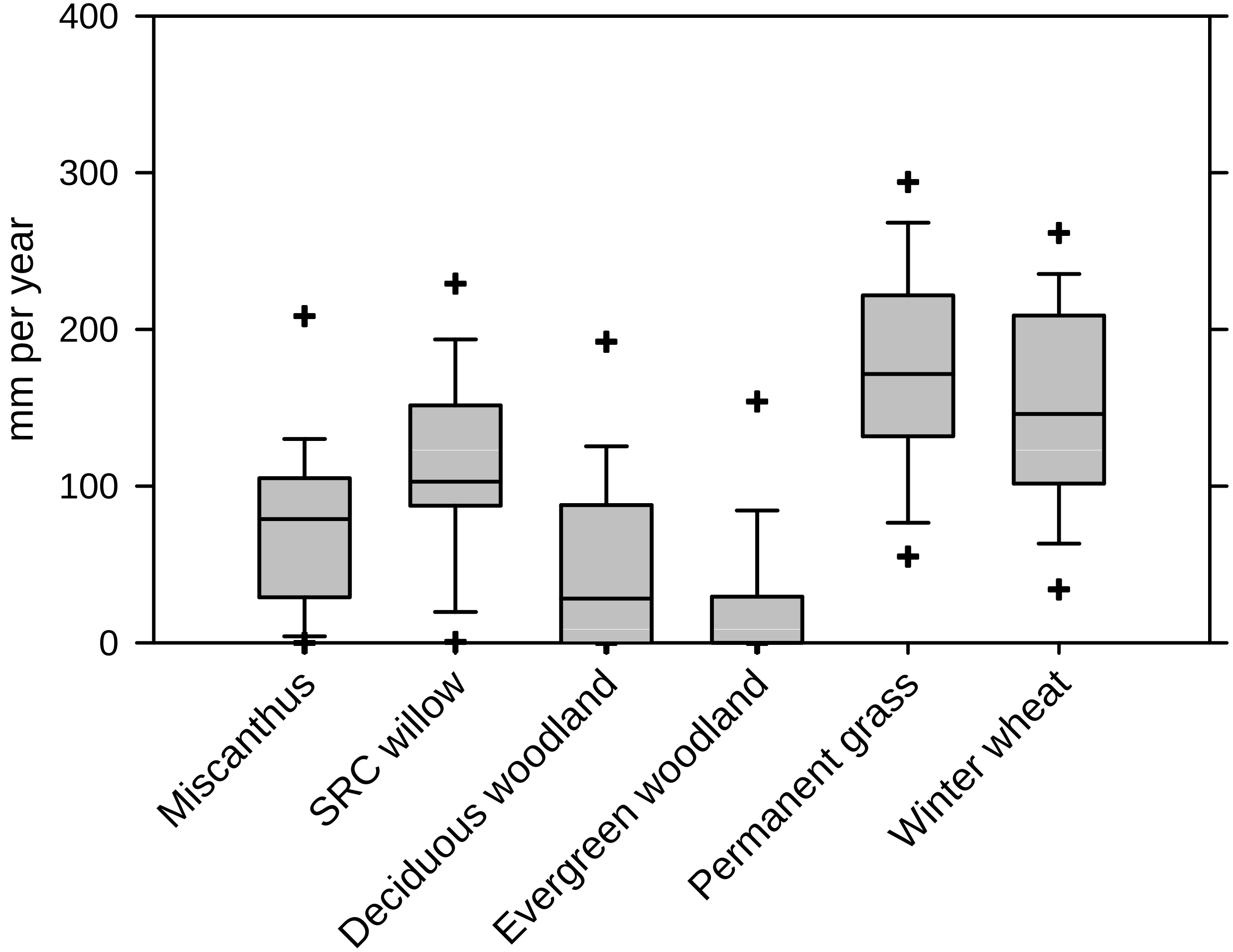
Simulated soil water contents



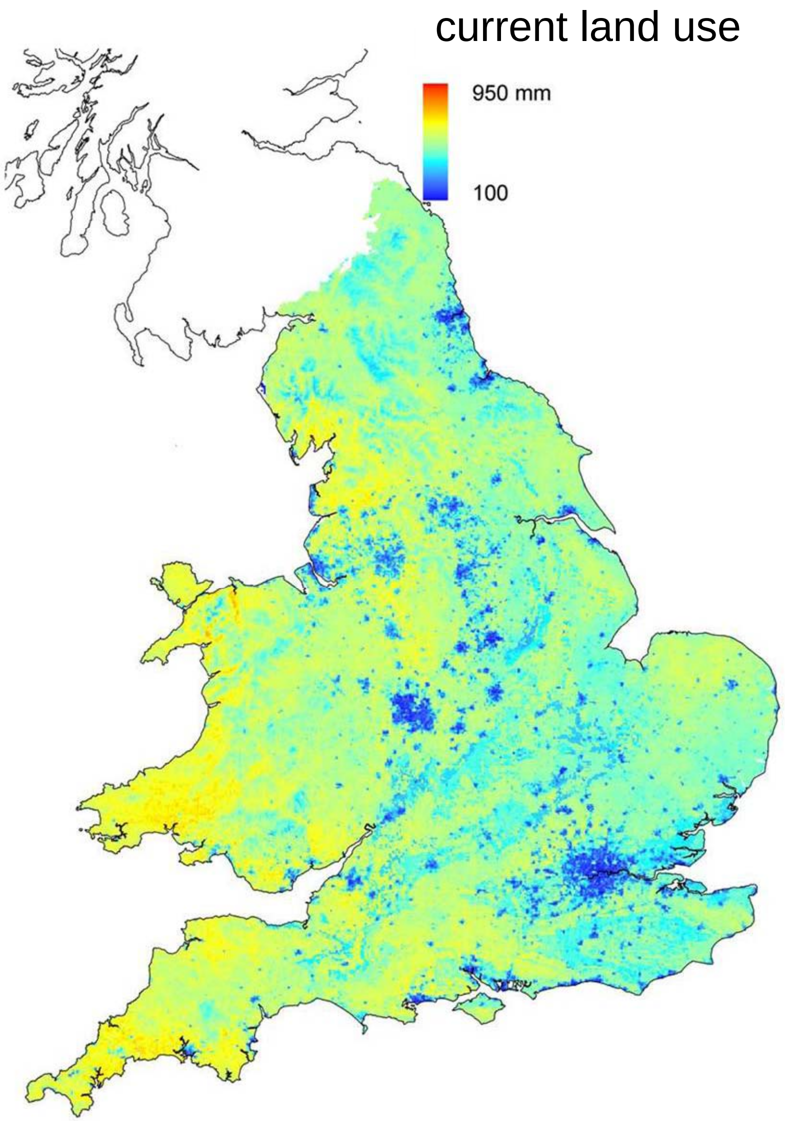
Simulated soil drainage

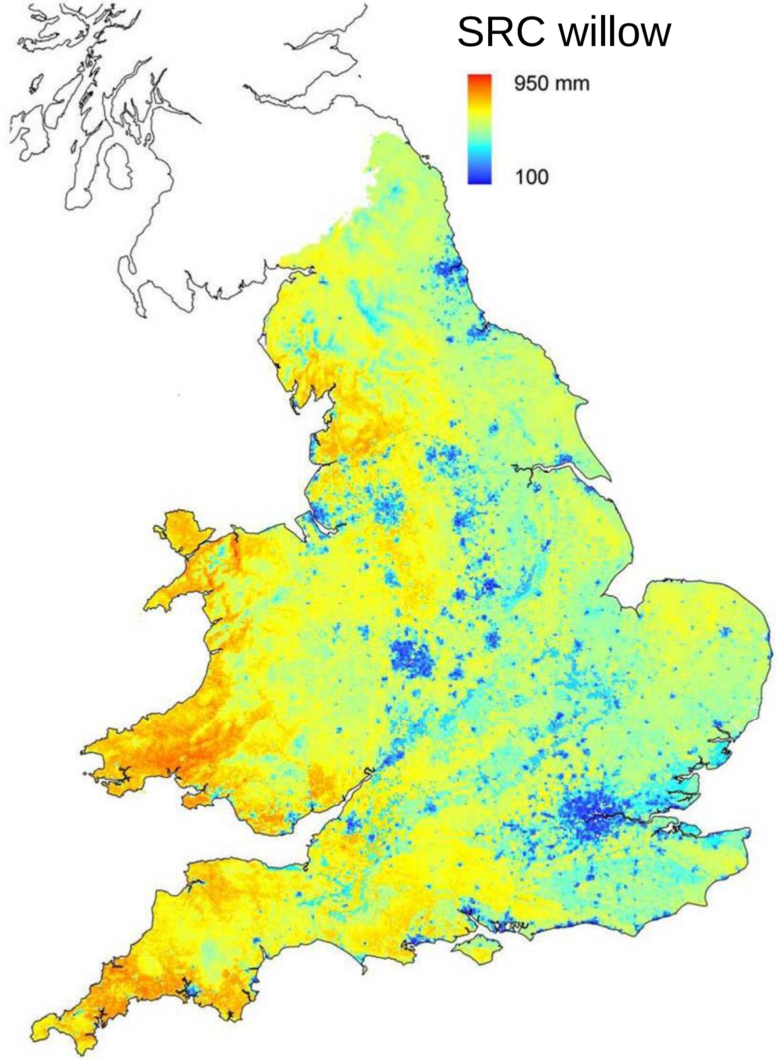
Wallingford 1972-2007

average annual rainfall 595 mm



Spatial variability of annual evaporation loss

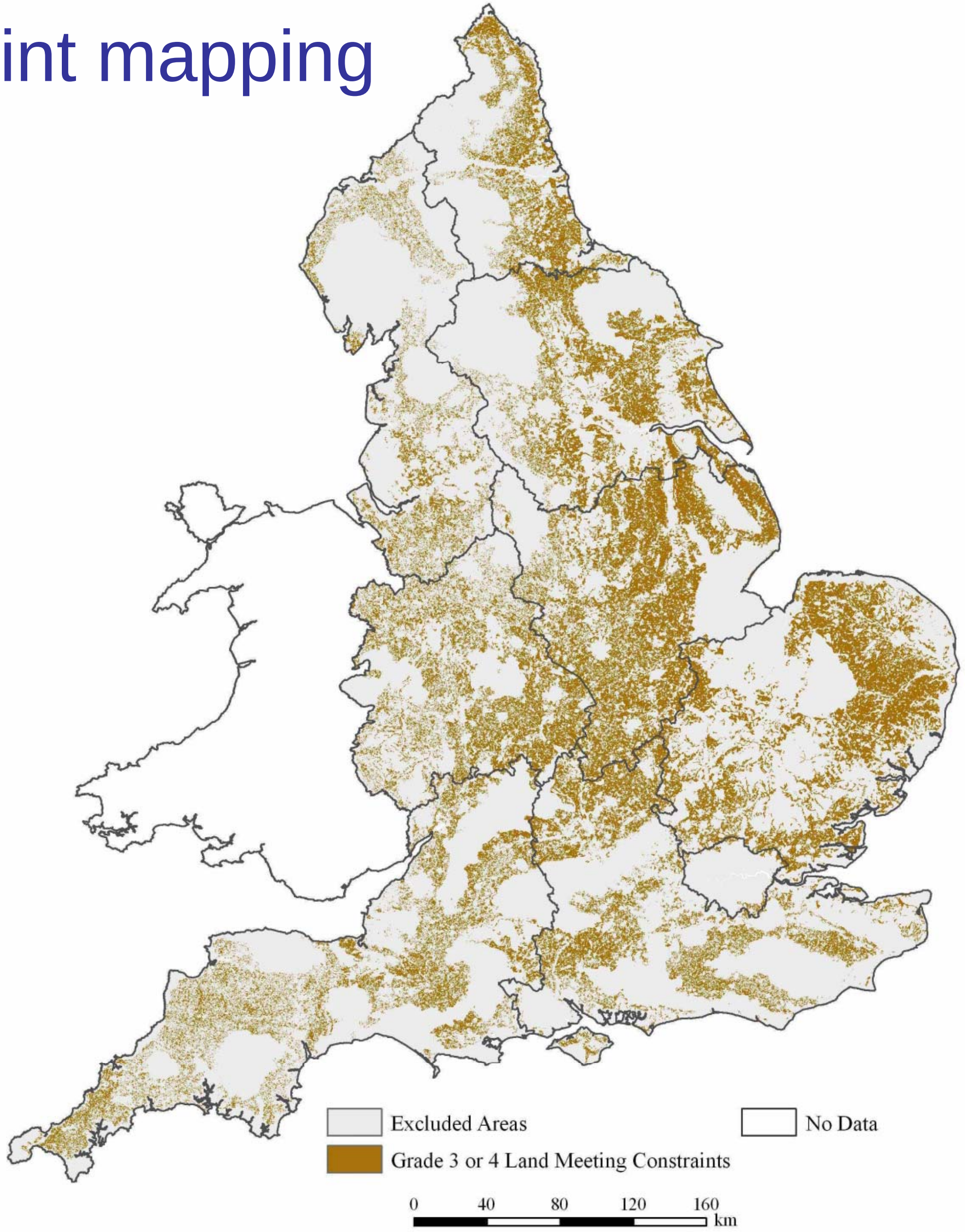




Constraint mapping

11 constraints used:
- topographic slope,
- soil type e.g. organic,
- natural habitats,
- woodlands,
- urban areas,
- lakes,
- major rivers,
- designated areas e.g. SSSI,
- cultural heritage,
- landscape sensitivity,
- improved grassland

Further restriction of Agricultural Land Classification 3 and 4



Lovett *et al*. Bioenergy Research, 2009

Farmer's perceptions

- Dominantly concerned with economics:
  - Long term commitment
    - Security of contracts
    - Fluctuations in prices of both the energy crop and food crops
    - Difficulty in calculating the returns
  - High establishment cost but several years before much income
  - Proximity to appropriate market(s)
  - Opportunity for diversification
  - Amount and reliability of the crop yields
- Crop management very different to their previous experience;
- Option that contractors do part or all of the work;

Sherrington *et al*. Energy Policy, 2008

Conclusions

- Conventional crops grown as energy feedstocks are unlikely to differ significantly from those grown for food
- Water quality impacts of biomass crops are likely to be beneficial due to low inputs of agri-chemicals
- Soil drainage may be less than under conventional crops and permanent grassland.
- Currently there is considerable uncertainty as to where these crops will be planted as it depends on a number of factors e.g.:
  - Constraints
  - Agricultural economics
  - Farmer’s attitudes
  - National and EU policies