Drainflow Risk Index

Introduction A spatial assessment of risk is the first aspect of the drainflow risk decision tree – "is the location where I propose using the product inherently risky?" In order to inform this question a drainflow risk index was developed to indicate the potential spatial risk that may arise from drainflow.

Approach The drainflow risk index combines the area (*SArea*) of five classes of soil requiring drainage with a modelled drainflow volume per drainflow day (*DFlow*) and weights this value with the proportion of soil requiring drainage likely to still contain surviving agricultural tile drains (*DrainPrev*), taking the form:

$$DRI = \left(\sum_{1}^{5} SArea * DFlow \right) * Drain\,\mathrm{Pr}\,ev$$

The methodology adopted was aligned with the UK higher tier drainflow risk assessment scheme (Hingston, J., Pers. Comm.) in accordance with the publication of Brown *et al.*, (2004) and CRD guidance documentation (Beulke, S. *et al*., 1998; Beulke, S. *et al*., 2002). The methodology was designed to cover England and Wales.

Soils The five classes of drained soils (see Table 1) were identified according to the classification scheme described by Brown *et al*., (2004) and as used within the UK higher tier drainflow risk assessment scheme (Hingston, J., Pers. Comm.). The extent of these soils (*SArea*) within England and Wales (see Figure 1a) was identified using NATMAP1000 (Soil Survey Staff, 1983). These were combined with the ADAS database of recent functioning drains (see Figure 1b) to determine a likely proportion of soils requiring drainage that are still drained by agricultural drains (ADAS, 2002).

The soils parameters required by MACRO v4.4.2 (FOCUS, 2001), the model used to derive the drainflow weights (*DFlow*), were derived according to CRD (Beulke, S. *et al*., 2002) and MACRO guidance documents (Jarvis, N.J., 1994; Jarvis, N.J. *et al*., 1997; Stenemo, F. and Jarvis, N.J., 2002; Stenemo, F. and Jarvis, N.J., 2003; Jarvis, N.J. *et al*., 2007) using soil property data taken directly from SEISMIC (Hallett, S.H. *et al*., 1995). Individual MACRO parameters were derived using the methods outlined below:

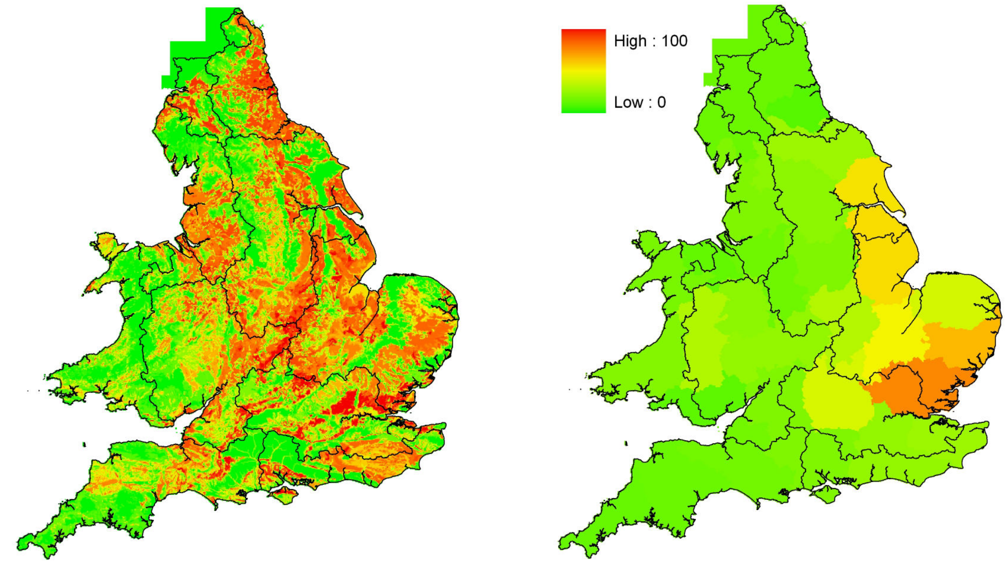
- CTEN – (Beulke, S. *et al*., 2002) using horizon clay content from SEISMIC

- TPORV, WILT, RESID, GAMMA – SEISMIC;
- XMPOR – Fitted Mualem Van Genuchten (MVG) curve to water release data in SEISMIC using SEISMIC MVG parameters and determined XMPOR at CTEN (Beulke, S. *et al*., 2002);
- FRACMAC and ASCALE - (Beulke, S. *et al*., 2002);
- ZLAMB – Fitted Brooks Corey curve to water release data in SEISMIC as well as XMPOR and determined ZLAMB by optimising the fit in accordance with Beulke *et al*., (2002);
- KSM – Calculated using variables described above and the equation provided in Beulke *et al*., (2002);
- KSATMIN – using equations provided in Beulke *et al*., (2002) adjusted for soil structural development according to Stenemo and Jarvis (2003);
- ZN - (Beulke, S. *et al*., 2002) implemented within the Footprint framework to determine values between the end members and for exceptional values (Jarvis, N.J. *et al*., 2007);
- ZP and ZA - (Beulke, S. *et al*., 2002);

The number of soil layers were defined according to the $FOCUS_{GW}$ guidance (2000) resulting in 22 layers for each soil profile. The degradation rate within each soil layer was calculated at the reference moisture (TPORV) for each soil layer and modified for depth in accordance with the $FOCUS_{GW}$ (2000) guidance. Drainage systems appropriate to each soils class were selected from the literature (Ragg, J.M. *et al*., 1984), the key attributes of which are summarised in Table 1.

Table 1: Summary of the drainage attributes used for each of the soil classes (after Ragg, J.M. *et al*., 1984)

Soil Class	Drainage Depth (m)	Drainage Spacing (m)
Denchworth	0.55	2
Hanslope	0.55	2
Clifton	0.8	20
Brockhurst	0.8	20
Quorndon	0.9	30



(a) (b)

Figure 1: (a) Percent of each 1km grid cell occupied by soils requiring drainage (after Brown *et al*., 2004) (b) Percent of soils requiring drainage with surviving drains (after ADAS, 2002)

Weather The daily weather data required by the MACRO model was sourced from the SEISMIC v2 software using the report generator. Four stations were selected to represent <600 mm, 600 mm-750 mm, 750 mm-1000 mm and >1000 mm climates. The four stations selected were Rosewarne (>1000 mm), Hillsborough (750-1000 mm), Wisley (600-750 mm) and Cambridge (<600 mm). Thirty six year records were compiled by replicating the first six years of the 30 year weather dataset for each station. This allowed MACRO to equilibrate soil hydrology using the first 6 years of data prior to running the thirty year record that was used in the compilation of the drainflow statistics. The UKCIP 1961 to 1990 baseline climate at a 5 km grid square resolution was used in the spatial analyses to define the four climate zones.

The MACRO v4.4.2 model (Jarvis, N.J., 1994) provided for standard FOCUS_{SW} modelling (FOCUS, 2007) was used to simulate the average number of drainflow days and drainflow volumes for each soil and climate combination.

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