# Development of a surface runoff vulnerability index


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## Introduction

In order to assess the feasibility of introducing $FOCUS_{SW}$ into the UK plant protection product regulatory process, the extent and contribution of surface runoff to aquatic exposure needs to be assessed more fully and is the focus of a Defra PSD funded project investigating "Surface runoff as a route of aquatic exposure to pesticides in the UK – PS2233".

## Objectives

The development of the surface runoff vulnerability index (VI) was designed to explore the potential spatial extent of surface runoff and identify sites and areas for more detailed analysis within later phases of the project.

## Methodology

It was envisaged that a surface runoff vulnerability index akin to the numerous groundwater vulnerability indices, for example DRASTIC (Aller *et al.* 1987) would be developed. The factors comprising the VI are combined additively to derive the total surface runoff vulnerability index:

$$\text{Surface Runoff Vulnerability Index} = \sum_{i=1}^{4} F_i W_i$$

where *F* is the Factor rating and *W* the weight to be applied to each factor *i*. There are a number of climatic and physical factors that affect the runoff process at the plot or hillslope scale. Climatic factors include rainfall amount and intensity while the physical factors include soils properties, topography and land management practices. The factors included in this surface runoff vulnerability index (Table 1) were selected following a review of the surface runoff literature and the role that they play in the generation of surface runoff and associated soil erosion/transportation processes. The factor ratings were defined using literature values and expert judgment akin to previous studies (e.g. Aller *et al.* 1987) and sensitivity tested. In this assessment the weights were all set to unity as the relative importance of each factor in the generation of surface runoff is not known. The surface runoff vulnerability index was not formally validated as datasets to do so are not readily available. Instead, a limited comparison with other study results, primarily from the soil erosion literature, was undertaken.

| Environmental Factor | Rating (*F*) |
|---|---|
| Climate (Rainfall Intensity/Amount) | L = 1 ⇒ H = 9 |
| Slope | 5-12% = 3; 12-19% = 6; 19-39% = 9 |
| Soil | All other soils = 0; R1/R3/R4 = 9 |
| Landcover/Landuse | Managed Grass = 5; Arable = 9 |

**Table 1: Summary of the factors and their ratings used in the derivation of the surface runoff vulnerability index.**

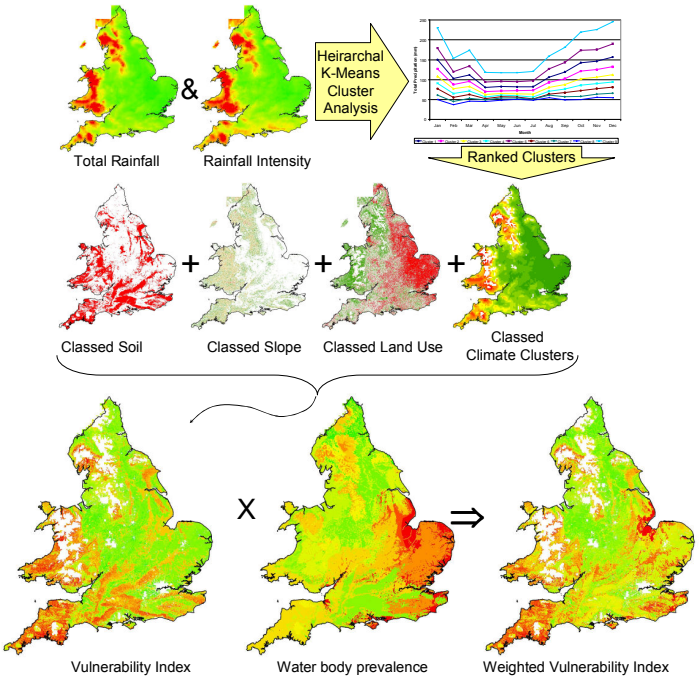


**Figure 1: Creation of the surface runoff vulnerability index (50 m version)**

## Results

The creation of the VI along with the results are illustrated in Figure 1. The influence of the east-west moisture, arable and topographic gradients are clear along with that of the soils/geology. However, the delivery of surface runoff generated in-field and its associated pollutants is affected by the presence of edge of field water bodies as well as a range of edge of field features and micro-topography, as illustrated in Figure 2, for example:

A. Contour cropping of the headland & foot slope
B. Plough feering at the edge of the buffer strip (as much as 25 cm)
C. Grassed buffer strips (typically 1.5 m to 8 m)
D. Bunded ditches
E. Hedgerow/Riparian vegetation

In order to address this connectivity issue at the landscape scale a further refinement was undertaken and a layer of water body density (km/km$^2$ of rivers, streams and ditches) normalised (0 to 1) and used to weight the vulnerability index (see Figure 1). Owing to the prevalence of ditches in some agricultural landscapes there is a clear east-west trend in the water body prevalence layer and this adds additional weight to the eastern areas while moderating the vulnerability in the west.

**Figure 2: Impacts of field edge features and micro-topography on delivery of in-field surface runoff to agricultural water bodies.**

## Summary

- A robust surface runoff VI has been successfully developed
- Comparison with other datasets (e.g. McHugh et al. 2003) suggests the VI is realistic although direct comparison is difficult
- Field sites have been identified using the VI and more detailed spatial (10 m and 5 m) and topographic analyses (e.g. slope shape) in high VI zones are currently underway
- The impact of these findings on the revised UK $FOCUS_{SW}$ scenarios (Price *et al.*, 2007) is also being assessed


### References

Aller, L., T. Bennet, et al. (1987). DRASTIC: a standardized system for evaluating groundwater pollution potential using hydrogeologic settings. U.S. EPA Report 600/2-85/018.

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