Integrated land-water risk analysis for the protection of sensitive catchments from diffuse pollution

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Diffuse pollution is a major management challenge as it commonly involved processes that are small in magnitude, distributed over a large spatial area and associated with certain land use types when they are well connected to the drainage network. Whilst some of these processes have been addressed in terms of water quality forecasting models and field measurements, we lack effective tools to prioritise where within a catchment action should be taken to remediate the diffuse pollution problem. From a management perspective, the required information is on ‘what to do where’ rather than exactly how much fine sediment is moving and when. This change in focus opens up the problem to be considered in a probabilistic/relative framework rather than concentrating on absolute values.

The SCIMAP risk mapping framework has developed a distributed treatment of surface hydrological connectivity based on the analysis of the potential pattern of soil moisture and saturation within the landscape. For each point in the landscape, the probability of continuous flow to the river channel network is assessed. This is achieved through the prediction of the spatial pattern of soil moisture and hence the susceptibility of each point in the landscape to generate saturated overland flow. For a point in the landscape to export risk in surface flow, every other point along the flow path to the channel must be capable of transporting the risk. If a down slope point is not also saturated, the upslope risk will be captured at this point and not reach the river channel, the cell is disconnected. The total risk that a point represents is a function of the point scale risk and the risk of connectivity to the river channel. These risks are accumulated through the river catchment to show the points in the landscape where there is a greater or lower risk of diffuse pollution impacting on the aquatic ecosystem.

The SCIMAP risk mapping framework has been applied to the River Eden catchment, northern England, UK. The results from this application are presented compared to both ecological and water quality data. The method was found to be able to predict the distribution of salmon fry and potassium on a catchment wide basis. The parameter uncertainty has been investigated in a GLUE style framework and it was found that they key controlling factors for salmon fry was the area of improved pasture, moorland and arable cover. For nitrate, the key controlling factors where found to be the area of arable land cover. The results of the uncertainty analysis have been expressed graphically as part of the risk map. From the top 0.1% of the investigated parameter sets, the mean and coefficient of variation has been calculated. The mean is then used to determine the colour the river channel and the size of the line is related to coefficient of variation which is related to the uncertainty associated with that point. This enables the targeting of points in the landscape that have the greatest predicted risk and that the SCIMAP framework is more certain that there is a problem at that location.