Geophysical Research Abstracts
Vol. 16, EGU2014-4045, 2014
EGU General Assembly 2014

Investigating the impact of land cover change on peak river flow in UK upland peat catchments, based on modelled scenarios

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Changes to land cover can influence the velocity of overland flow. In headwater peatlands, saturation means that overland flow is a dominant source of runoff, particularly during heavy rainfall events. Human modifications in headwater peatlands may include removal of vegetation (e.g. by erosion processes, fire, pollution, overgrazing) or pro-active revegetation of peat with sedges such as Eriophorum or mosses such as Sphagnum. How these modifications affect the river flow, and in particular the flood peak, in headwater peatlands is a key problem for land management. In particular, the impact of the spatial distribution of land cover change (e.g. different locations and sizes of land cover change area) on river flow is not clear. In this presentation a new fully distributed version of TOPMODEL, which represents the effects of distributed land cover change on river discharge, was employed to investigate land cover change impacts in three UK upland peat catchments (Trout Beck in the North Pennines, the Wye in mid-Wales and the East Dart in southwest England). Land cover scenarios with three typical land covers (i.e. Eriophorum, Sphagnum and bare peat) having different surface roughness in upland peatlands were designed for these catchments to investigate land cover impacts on river flow through simulation runs of the distributed model. As a result of hypothesis testing three land cover principles emerged from the work as follows:

Principle (1): Well vegetated buffer strips are important for reducing flow peaks. A wider bare peat strip nearer to the river channel gives a higher flow peak and reduces the delay to peak; conversely, a wider buffer strip with higher density vegetation (e.g. Sphagnum) leads to a lower peak and postpones the peak. In both cases, a narrower buffer strip surrounding upstream and downstream channels has a greater effect than a thicker buffer strip just based around the downstream river network.

Principle (2): When the area of change is equal, the size of land cover change patches has no effect on river flow for patch sizes up to 40000m2.

Principle (3): Bare peat on gentle slopes gives a faster flow response and higher peak value at the catchment outlet, while high density vegetation or re-vegetation on a gentle slope area has larger positive impact on peak river flow delay when compared with the same practices on steeper slopes.

These simple principles should be useful to planners who wish to determine resource efficiency and optimisation for peatland protection and restoration works in headwater systems. If practitioners require further detail on impacts of specific spatial changes to land cover in a catchment then this modelling approach can be applied to new catchments of concern.