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Scale effects on the hydrological impact of upland afforestation and drainage using indices of flow variability: the River Irthing, England

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Abstract. Frequent assertions by river users that rivers in northern England now rise and fall more quickly than in the past, have never been validated by analysis on catchments of more than 10 km². The method using indices of flow variability provides a basis for making direct measurements of the annual number and duration of pulses, i.e. rises above a given flow, and for comparing catchments of different sizes. A comparison is made between the small afforested headwater Coalburn catchment (1.5 km²) and the larger River Irthing catchment (335 km²) on which the afforested area comprises 19%. A simple but effective means is provided for decoupling the effect of climatic variability from the effects of land use. The analysis shows that major changes have occurred on the small catchment, first with rising pulse numbers after pre-afforestation drainage, then with a much greater progressive decrease in pulse number accompanied with increasing pulse duration. In contrast, the larger catchment shows little change in variability indices from the beginning of its record in 1968 until the late 1980s after which the pattern of change mirrors that at Coalburn but the proportional change is much smaller. The direction of change is the opposite of that asserted by river users.

Keywords: hydrology, flow variability, land-use impacts, forests, scale effects

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