Geophysical Research Abstracts, Vol. 8, 04366, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04366

Towards a unified theory of runoff generation in montane watersheds: using process-based maps of soil hydrology to identify first order controls.

C. Soulsby (1), D. Tetzlaff (1), S. Waldron (2), S.M. Dunn (3), I.A. Malcolm (4)

(1) Department of Geography and Environment, University of Aberdeen, AB24 3UF, Scotland, UK, (2) Department of Geography and Geomatics, University of Glasgow, G12 8QQ, UK, (3) The Macaulay Institute, Craigiebuckler, Aberdeen, AB15 8QH, UK, (4) FRS Freshwater Laboratory, Faskally, Pitlochry, PH16 5LB , UK (c.soulsby@abdn.ac.uk / phone + 44 1224 272344)

A major constraint on attempts to find unifying theories in hydrology is the fact that different processes emerge at different spatial scales, often in a manner that is unknown. A further constraint is the reality that catchments often have a "uniqueness of place", with specific combinations of landscape controls that are characterised by heterogeneity at all scales. In attempt to explore these issues further, the influence of catchment scale and landscape controls on hydrological sources and mean residence times were assessed using long-term data collected from 4 individual mesoscale (16-230km^2) catchments in the uplands of northern Scotland. Data were collected from nested sub-basins of each catchments so that data were available for 25 individual basins at scales ranging from 0.9 – 230km^2 in size. Geochemical and isotopic tracers were used to carry out chemical hydrograph separations to quantify the relative contribution of different hydrological sources to annual runoff and estimate mean residence times in each catchment. Mean annual groundwater contributions varied between 23 – 62% of annual runoff, and mean residence times varied between 83 days – 840 days. GIS analysis was used to assess the nature of landscape controls on hydrological sources and residence times. Neither of these hydrological descriptors related to catchment scale. Both were correlated with various topographic indices (e.g. mean slope and flowpath length), but the strongest relationships were exhibited with catchment soil cover derived from the UK HOST (Hydrology Of Soil Types) digital data base. The soil maps were found to be effective "carriers" of process-information and soils

could be divided between more hydrologically “responsive” montane soils (e.g. peats, rankers, peaty gleys), which mainly generate storm runoff and more “free-draining” soils (e.g. brown soils and humus-iron podzols) which mainly facilitate groundwater recharge. The paper shows that for developing a unified theory for regionalizing our understanding of watershed functioning - at least at the scale of a geomorphological province such as northern Scotland - accurate digital soil maps can be an invaluable tool. The data derived from 4 mesoscale watersheds in this diverse geographical region show that soils integrate the effects of heterogeneities in catchment topography, geology, climate and vegetation and act as a first order control on catchment runoff generation. Thus, process-based soil maps have considerable potential for contributing to a unified theory for understanding hydrological response and making predictions in ungauged basins.