EXPLORING HYDROLOGICAL RESPONSE PATTERNS AT THE CATCHMENT SCALE USING “SNAPSHOTS” MEASUREMENTS

Pascal SZEFTEL, Markus WEILER
Department of Forest Resources Management, Faculty of Forestry
University of British Columbia

INTRODUCTION
Cotton Creek is a 17.4 km² snow-dominated watershed located in the Rockies, near Cranbrook (BC). The catchment is drained by two main streams, Elk Creek to the North and Cotton Creek to the South, both gauged continuously at 9 stations according to a nested design (Figure 1A). The forest cover patterns and the road network are evidences of recent logging activity (Figure 1B). The catchment is drained by two main streams, both gauged continuously at 9 stations according to a nested design (Figure 1B). Its main topographic features are described in Figure 2A-B.

In the present study, we propose a scale connecting, geographic aggregative approach, considering the studied watershed as a collection of contiguous hillslopes.

By taking “snapshots” of the hydrological response of the catchment, we aim to:
- Approach the spatiotemporal variability of lateral inflows along the stream channel
- Describe the subsurface flow pathways and their origins
- Establish what controls these subsurface flows

RESULTS
FLOW ANALYSIS
Local specific discharge is plotted versus statistics of topographic parameters of the local area: mean, median, and standard deviation (stdev) of slope and elevation. The local specific discharge is also linked to the percentage of logged area. R² of the linear regressions for each of these relations are shown in Tables 1A and 1B to illustrate the goodness of fit of these relations. An example is shown in Figure 6.

Across all these relationships, R² ranges from 0.0 to 0.139. The highest R² occur in June, during the snowmelt season. (Table 1B). This can be explained by the fact that spatial water input (melting snow) is correlated with altitude (snow line regression) and slope (greater slope on top of the catchment).

However, in general, lateral inflows are very poorly correlated with topographic or landscape features. Topography does not control the patterns of subsurface lateral inflows to the stream network.

HEADWATER SUB-BASINS
Subsurface flow patterns are inferred from the longitudinal profiles of specific discharge within the 4 headwater sub-basins (Figure 7). Based on these results, a conceptual model of subsurface flow contribution to the stream network is drawn for each of the basin (Figure 8).

REFERENCES
MOORE B. D. Slag injection using salt in solution. Streamline Vol. 8, Number 2, Spring 2005

CONCLUSION
Based on this study, it appears that common parameters (slope, elevation, land cover) failed to describe the lateral inflow patterns to the stream network. Since water supply to the stream is dominated by subsurface flow, surface topography is not appropriate to explain its spatial variability.

Electric conductivity patterns allowed us to explore the distribution of subsurface flowpaths at the catchment scale but further investigations are needed to fully understand the inflow patterns and quantify the shallow and deeper subsurface flow pathways.

The comparison of the hydrological response of the 4 headwater sub-basins showed significant differences despite similar topographic features and altitude (similar water input along the year). For each of the sub-basins, the consistency of the response patterns along the year tend to prove that these patterns are independent of water input and rely only on subsurface flow pathways.

METHODS
Spatial variability
A “snapshot” consist of 52 salt dilution measurements carried out along the stream network at specific sites (Figure 3) within two days. The stream gauging procedure follows the recommendations by Moore (2004). At each site, the background electric conductivity (EC), stream temperature (T) and discharge (Q) are measured.

Temporal variability
Three snapshots of the hydrological response of the watershed have been collected, in June, August and October (respectively wet, intermediate and dry states).

EC value is a surrogate of the concentration of ions in the water. Thus, we expect greater EC value from water that has resided underground longer and solved the ions from the surrounding soil and rock. The lateral inflow electric conductivity is plotted versus mean and median of elevation and slope of the local area and topographic features are described in Figure 2A-B. The linear regressions are summed up in Tables 2A and 2B. An illustration is shown in Figure 9.

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