Soil moisture mapping using LiDAR-DEM derived soil wetness indicators

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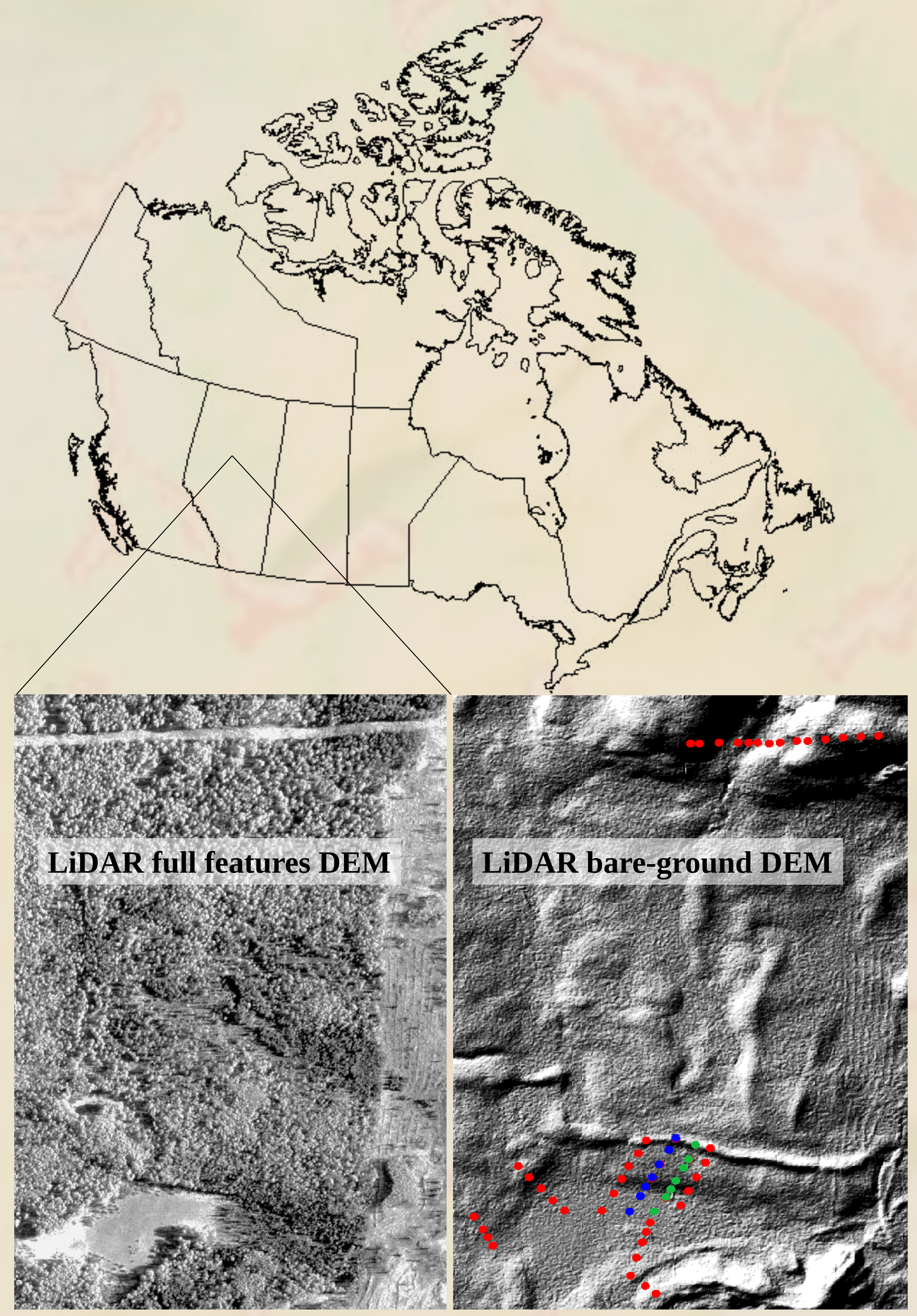
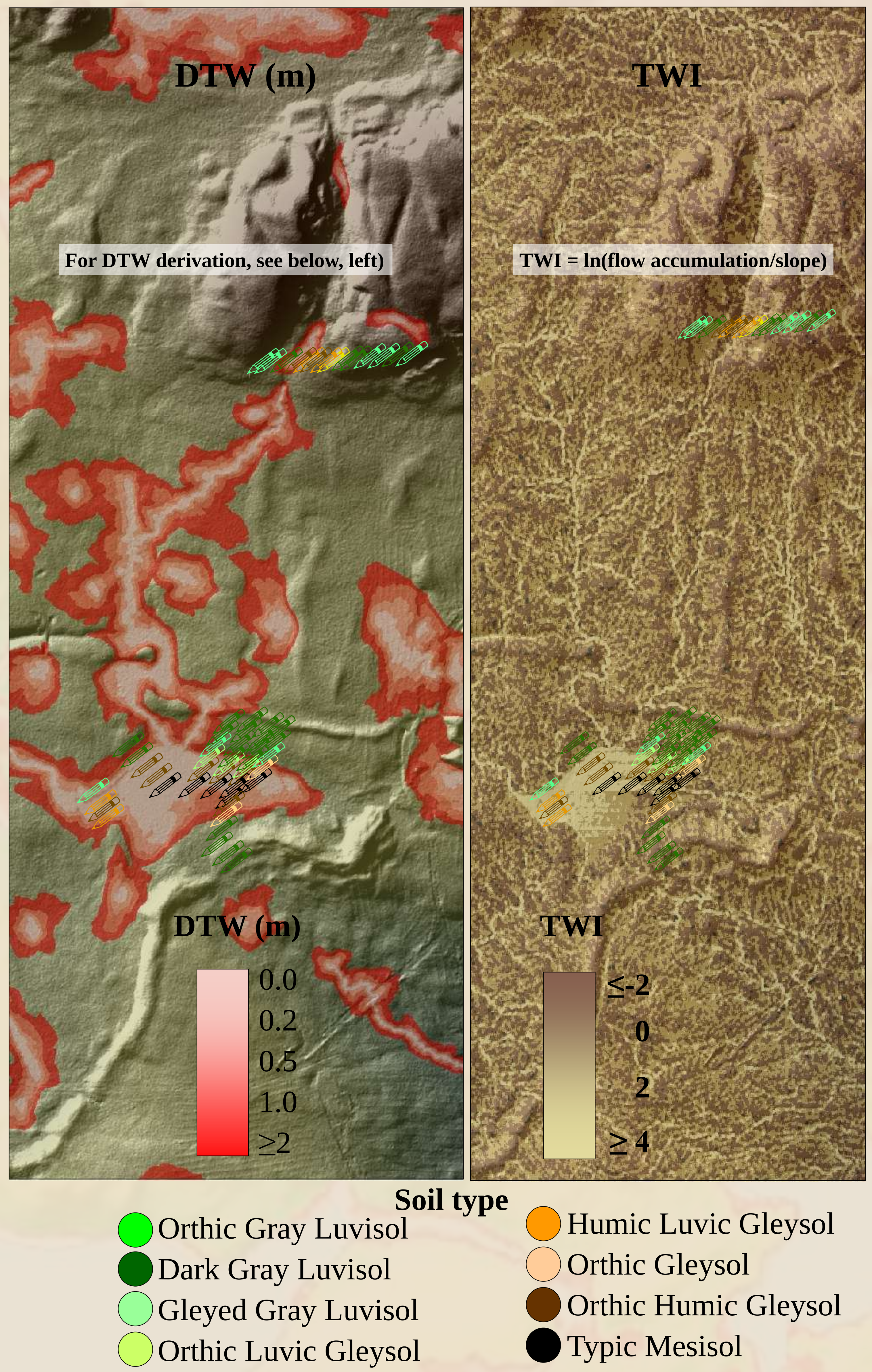
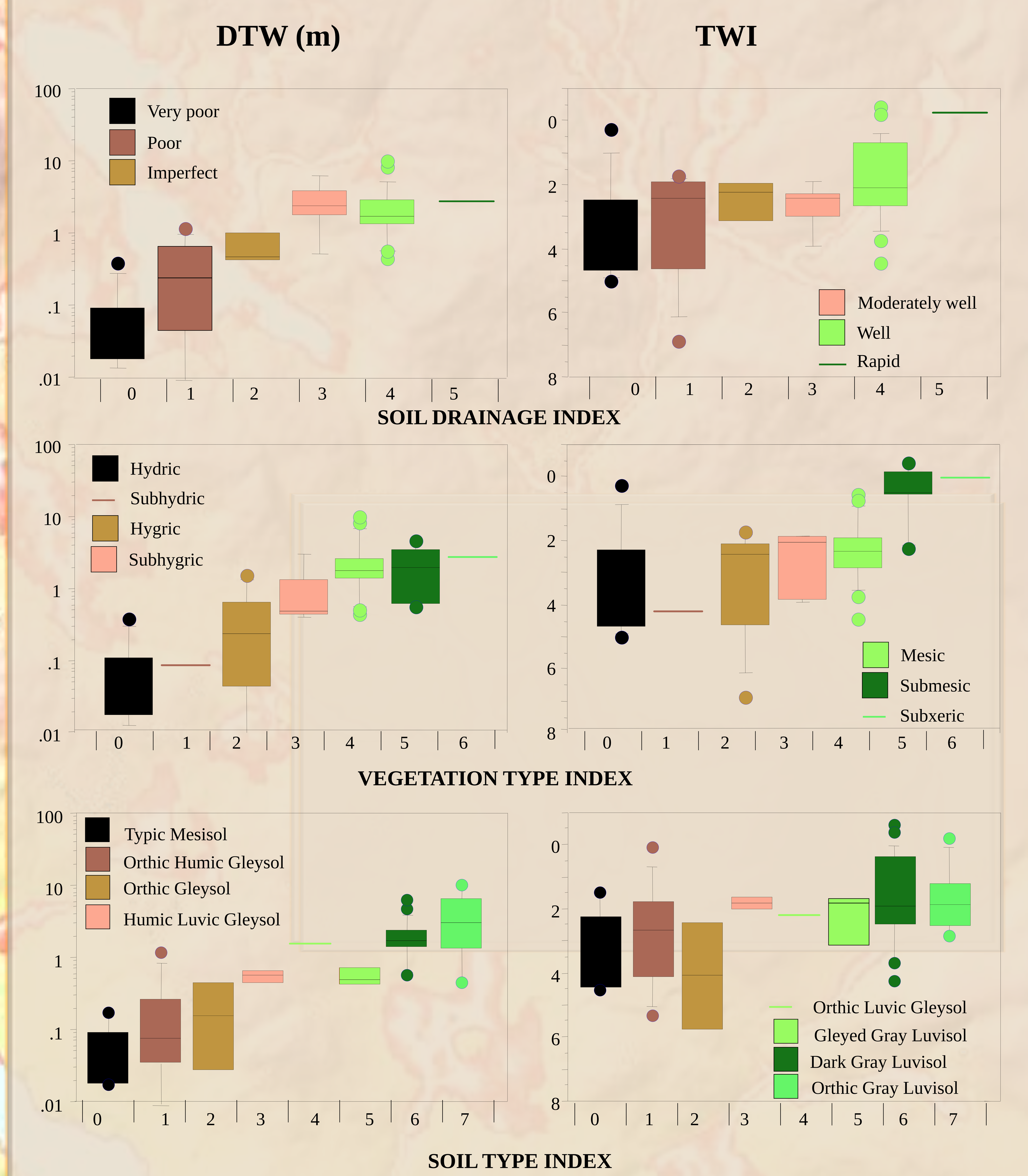
Introduction

This poster demonstrates the utility of a digitally derived depth-to-water index (DTW, immediate right) and a terrain wetness index (TWI, further right) to model and map field-determined variations in drainage, vegetation and soil type and select soil properties along a soil topo-sequence within a forested area of the Swan Hills, Alberta, Canada (below). Both DTW and TWI were derived from a LiDAR (Light Detection and Ranging)-based digital elevation model (DEM, 1m resolution). Field determinations regarding drainage type (very poor to excessive), vegetation type (hydric to xeric) and soil type (mesisols through gleysols to luvisols), and soil moisture were obtained along downslope-upslope soil transects. Field-assessed drainage, soil and vegetation type conformed more closely to DTW (R^2>60%) than TWI (R^2<25%). Soil moisture was also correlated with DTW than with TWI, with and without soil depth as an additional variable as part of the regression analysis.

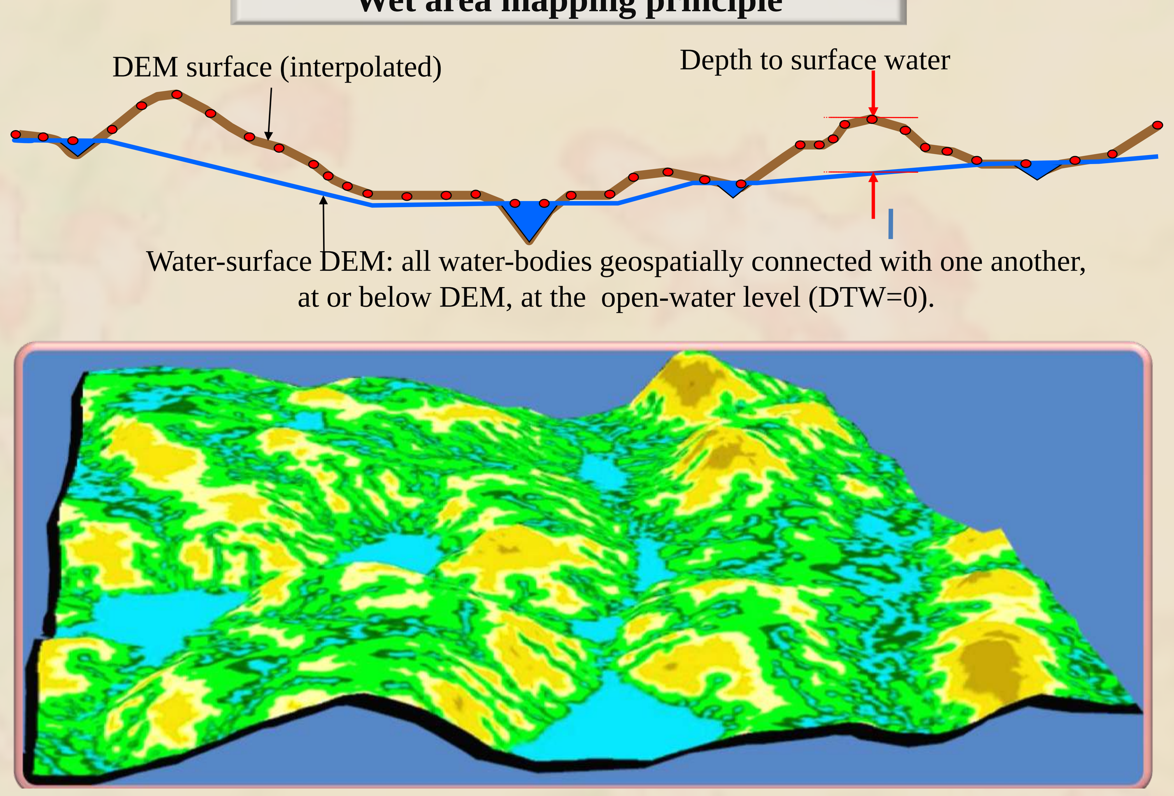


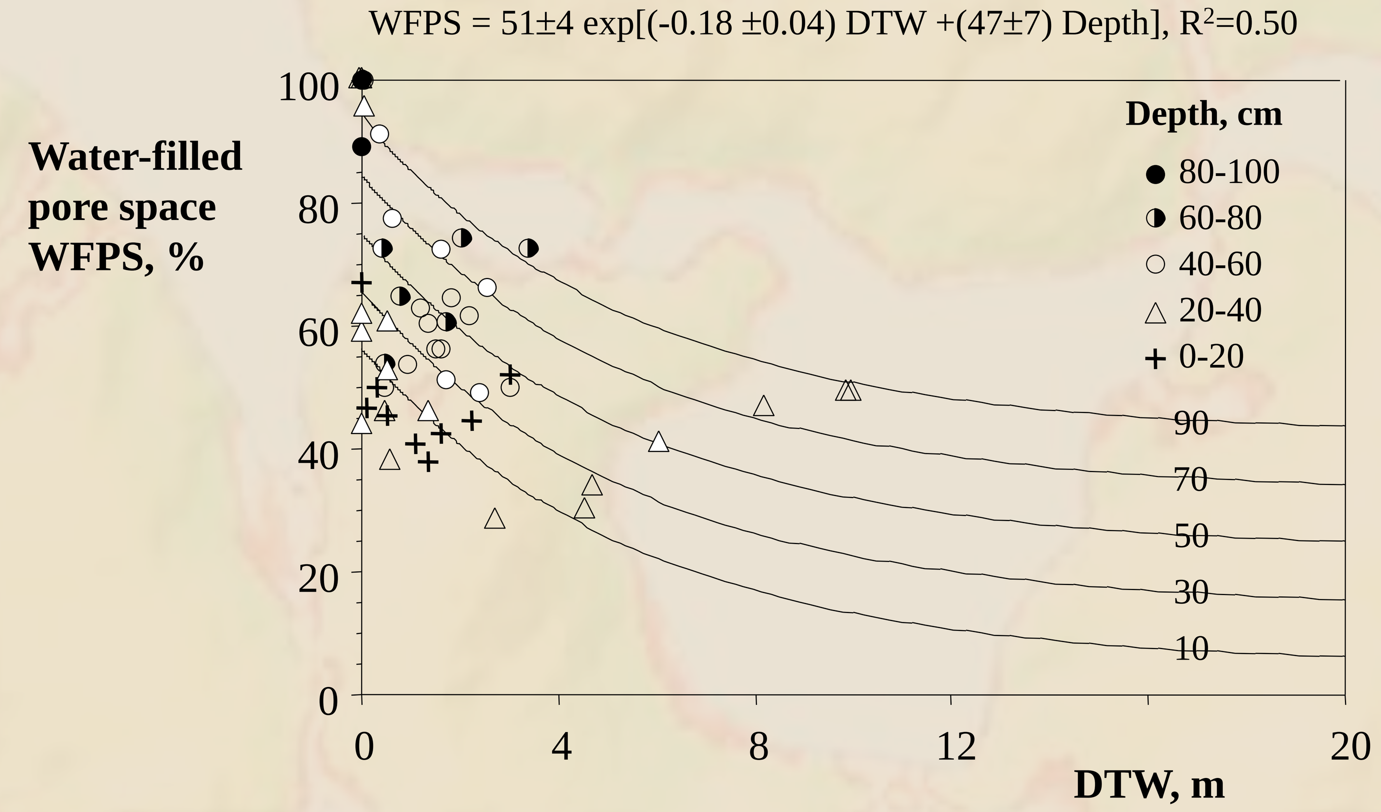
Soil Transects: • Soil pits • Soil cores • Soil cores (verification)





Wet area mapping principle





Summary

The availability of high-resolution DEMs makes it possible to re-examine and map soil spatial conditions and properties in relation to topographically derived soil or terrain wetness indices. Among these, the DTW index appears to be fairly reliable and consistent in delineating soil type, vegetation type, drainage, and soil moisture content, at high-resolution. The derivation of the DTW index also provides a means to further refine other surface and land survey information pertaining to wet areas and open-water features (Murphy et al. 2009). For the example of this poster, DTW captured more than 60% of the transect-determined variations in soil and vegetation type and drainage conditions for the study area, which is an improvement over the 25 to 45% variations captured with the commonly used TWI index.

The extent to which soil properties can be projected and mapped to actual location and soil layers by way of DTW alone or in combination with soil depth, however, remains limited on account of various processes and factors that locally generate additional vertical and lateral soil variations.

Murphy, P.N.C., Ogilvie, J., Arp, P.A., In Print. Topographic modelling of soil moisture conditions: a comparison and verification of two models. Eur. J. Soil Sci.

Murphy, P.N.C., Ogilvie, J., Castonguay, M., Meng, F.-R., Arp, P.A., 2007. Verifying calculated flow accumulation patterns of mapped and unmapped forest streams by culvert location. Forest Chron. 83, 198-206.

Murphy, P.N.C., Ogilvie, J., Meng, F.-R., Arp, P.A., 2008. Stream network modelling using LiDAR and photogrammetric DEMs: a comparison and field verification. Hydrol. Process. 22, 1747-1754.