CASE STUDY 7: MONITORING AND IMPROVING CROP-SOIL-WATER DYNAMICS ACROSS SWAT ZONES

Moisture variability across a field and throughout a growing season was measured through the 2025 growing season for a wheat crop in Saskatchewan (Figure 1). Crop water use varied substantially by SWAT zone, ranging from approximately 145 mm to over 220 mm of cumulative water use, despite uniform weather and crop type. These differences evolved through the season as rooting depth expanded at different rates across zones, influencing access to stored soil water. Daily changes in volumetric water content (VWC) revealed distinct patterns of water gain and loss at multiple soil depths, highlighting how the crops located in the mid slope (6) and depression (9) consistently retained and utilized water more effectively than those on the hilltop (4).

The addition of SWAT CAM bare soil exposure (Figure 2) from an early growing season sprayer pass was critical for explaining the low water use of Zone 4. The SWAT CAM imagery identified that the Zone 4 corresponded to hilltop areas with higher bare soil exposure (up to 40% bare soil) versus mid slope and depressional areas with minimal soil exposure (<5%). Bare soil has much higher soil evaporation and runoff potential thus limiting the amount of water available for infiltration and subsequent crop uptake. By integrating surface condition indicators with soil moisture and crop water use data, cause-and-effect understanding is possible.

With the extent of bare soil exposure clearly delineated targeted intervention strategies are possible. Runoff and soil evaporation prevention measures, specifically those aimed at increasing surface residue, can now be focused on the SWAT CAM identified hilltop areas with high soil exposure. Continued observation of soil moisture dynamics, crop water use, and surface residue provides the opportunity to evaluate and validate the impact of an intervention over time. By tracking whether soil water retention improves and whether seasonal crop water use increases in treated zones, farmers can directly assess whether the chosen practices are sufficient or if further adjustment is required.

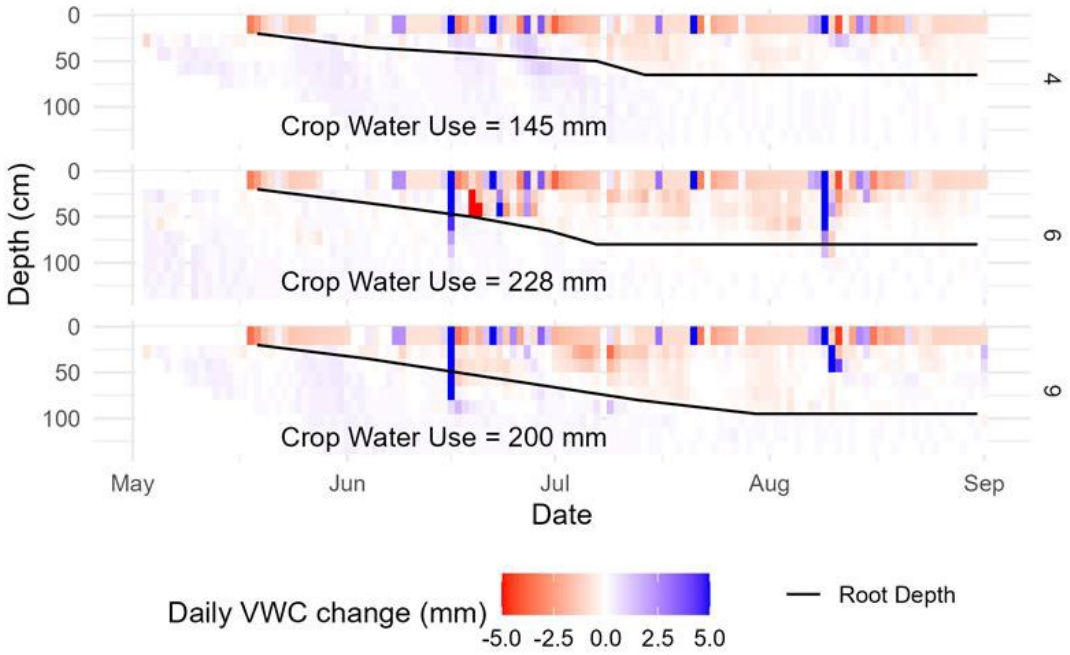

Figure 1. *Daily soil water change for an array of soil moisture probes installed across a SWAT zone gradient (Zone 4, 6, and 9). Blue colors indicate an increase in soil moisture (infiltration/redistribution) and red indicates a decrease in soil moisture (plant uptake/soil evaporation). Total change in soil moisture over the growing season is summarized as crop water use. Root depth progression is estimated by the black line.*

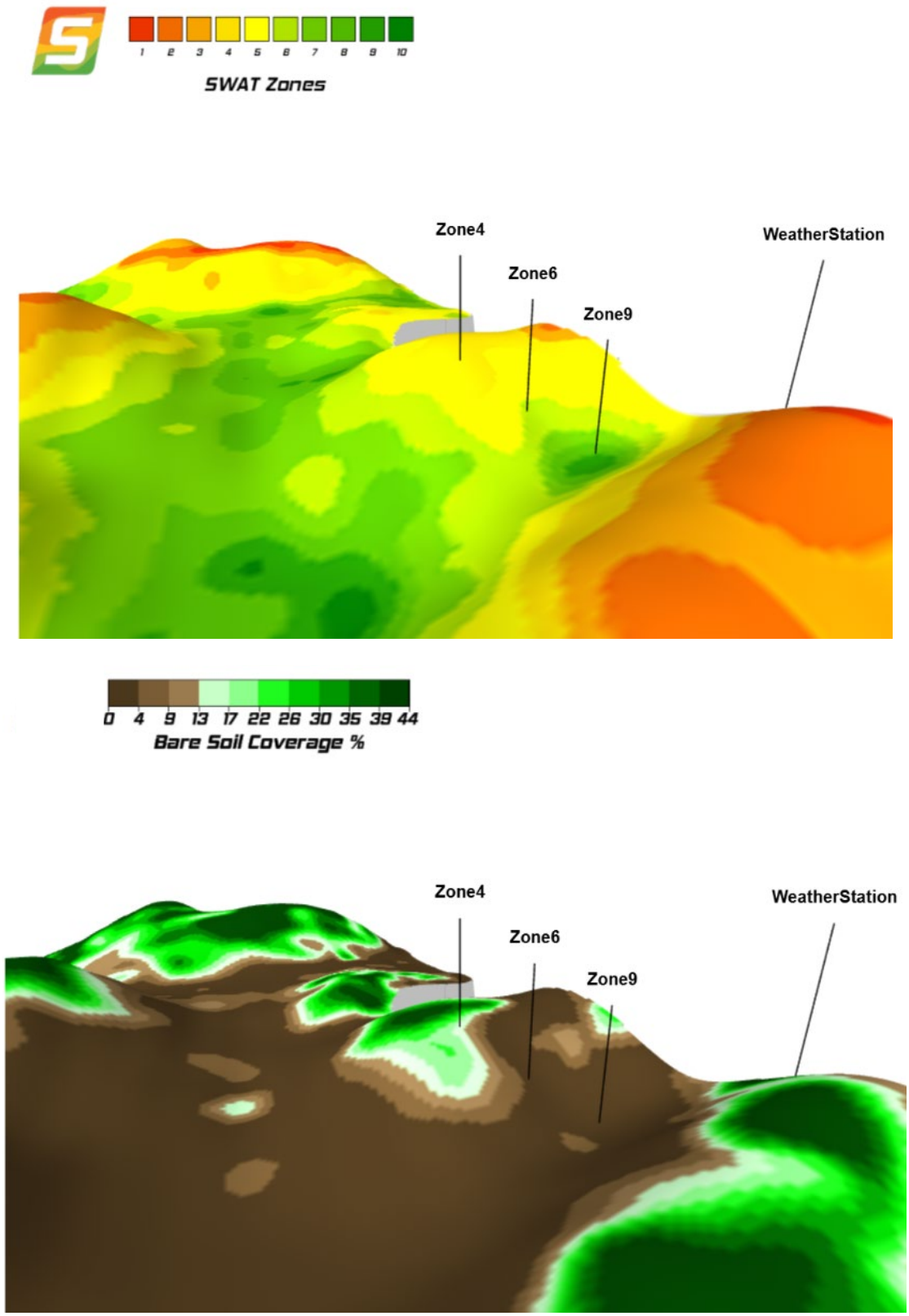

Figure 2. *(top) SWAT MAP with location of soil probes identified and (bottom) bare soil coverage as quantified by SWAT CAM at the start of the growing season.*