Ecohydrology of a reclaimed landscape: Nikanotee Fen Watershed

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The pre-disturbance landscape of northern Alberta is comprised of a mosaic of upland-wetlland complexes. As such, these landscapes have become the focus of recent, mandatory reclamation efforts in the region. However, creating a functional, self-sustaining ecosystem in the region is further complicated by the regions sub-humid climate and large evaporative losses, resulting in frequent periods of water stress. Thus, quantifiable metrics for evaluating the trajectory and long-term sustainability of reclamation projects are required. Here we evaluate the reclamation performance of one of the first constructed upland-peatland complexes (Nikanotee Fen Watershed) through a functional-based, ecosystem-scale approach focused on carbon dynamics and water use efficiency (WUE). Growing season observations during the initial seven years (2013–2019) following construction were measured using the eddy covariance technique and paired with multispectral imagery to capture ecosystem evolution. Results indicate ecosystem functionality is closely linked to plant growth and establishment. The fen quickly evolved from a bare-ground, carbon source in 2013 to a sedge-dominated (Carex aquatilis), carbon sink by 2015 (net ecosystem exchange (NEE) of 70 to -243 gC m-2 year -1). The slower growth rate of trees (Pinus banksiana, Populus balsamifera) coupled with dry edaphic conditions in the upland resulted in net carbon losses during the study period (NEE of 519 to 46 gC m-2 year -1 from 2013-2019). However as upland vegetation has become more robust, there has been an increase in plant CO2 uptake. As the canopy continues to develop, the upland is on trajectory towards become a net carbon sink in near future. WUE rates in both the fen and upland show a marked increase once vegetation becomes well established. Notably, from 2015 onwards, fen WUE rates remain relatively stable (2.24□0.35 gC kg-1H2O) even though seasonal rainfall inputs fluctuate between years (ranging from 167 to 285 mm season-1). Stable WUE rates are indicative of a well-connected groundwater network between the two landscapes resulting in sufficient hydrological self-regulation. As a result, there is adequate plant-water availability, and plant function in the fen is no longer solely dependent on precipitation inputs – increasing the systems resilience to intervals of periodic water stress. Overall, assessment of the carbon and water dynamics during early-development suggests the constructed system is evolving towards becoming a self-sustaining, carbon-accumulating, functional ecosystem.