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Differences in the Potential Hydrologic Impact of Climate Change to Athabasca and Fraser River Basins of Canada with and without Considering Shifts in Vegetation patterns Induced by Climate Change

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In western Canada warmer climate could lead to forest retreat and grassland expansion, which tend to have deeper snow packs than forested areas, yielding increased spring runoff and mean annual flow. This process was evident in the central Fraser River Basin (FRB), which is substantially drier than the mountainous regions along the basin's outer boundary. Vegetation shifts in mountainous regions of FRB are expected to be dominated by conifer/broadleaf competition, which could translate into smaller changes in annual runoff yield than forest/grassland competition. Under several GCMs' climate projections, the overall flow in FRB is expected to increase due to significant increases in rainfall. In the Athabasca River Basin (ARB), several climate projections predicted an expansion of the boreal forest into areas currently classified as conifer savannah. The loss of grassland area resulted in decreased flows in three of the vegetation scenarios (GISS, HCS, and UKMO). Given all the GCMs examined predict significant increases in annual temperatures, and by considering vegetation shift, the simple water budget model used in MAPSS for representing available soil moisture projects that soils will become wetter in much of ARB. This is inconsistent with the projections of the more detailed, land surface scheme, MISBA, which projects drier conditions and decreased stream flows in ARB. This inconsistency likely suggests that the treatment of hydrologic factors in vegetation models needs to be improved before detailed conclusions can be drawn from a series of stand-alone simulations. Ideally a detailed land surface scheme should be coupled with a vegetation model to avoid overestimating the likely range of flows (e.g., probably GISS and HCS in the ARB and possibly UKMO in the FRB). Vegetation models used assume equilibrium conditions which may take more than a century to occur or may never occur if species migration rates are too slow and key ecological functions are lost and never replaced. They also cannot account for anthropogenic impacts such as agricultural practices, and possible increased forest fires due to warmer climate.