Geophysical Research Abstracts
Vol. 13, EGU2011-8962-2, 2011
EGU General Assembly 2011

Interaction of Aspen forest and harvesting with climate and geology on sink-source dynamics: conceptualizing the regional hydrology of a complex low relief terrain, Western Boreal Plain, Canada.

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The Western Boreal Plain (WBP) eco-region of western Canada is experiencing unprecedented industrial development for forest, oil and gas resources, stressing the need to assess and understand the sink and source areas of regional water flow. This requires the development of models that can be use to predict and mitigate the impacts of land use changes on water quantity and quality. The WBP is characterized by low relief, hummocky terrain with complexes of forestlands and wetlands, especially peatlands. A paired aspen forest harvest experiment (HEAD2) was conducted on adjacent pond-peatland-aspen forestland complexes of a moraine landform, ubiquitous throughout the WBP, to determine the influence of aspen vegetated forestlands and harvesting relative to wetlands on local and regional water cycling. Reductions in transpiration and interception following aspen harvest resulted in some increase in soil moisture. However, excess water was largely absorbed into deep moraine substrates and resulted in groundwater recharge with little or no lateral flow to adjacent wetlands and aquatic systems. As a result of high soil and groundwater storage there was no observable difference in runoff from the harvested catchment compared to the adjacent reference (uncut) catchment confirming that in most years runoff originates from the wetland (peatlands) rather than forestland hydrologic units. Furthermore, soil moisture increases were short lived due to rapid redevelopment of leaf area as result of high density regeneration of aspen through root suckering. Recovery of transpiration and interception to near pre-harvest conditions occurred within 3 years. Climate cycles, primarily inter-annual variation in snow pack, can overwhelm the influence of aspen harvest in the WBP. During the harvest experiment large water table rises were observed in both the uncut and the harvested forestlands. This study illustrates that forestlands on deep moraine hummocky substrates of the WBP act essentially as water sinks, with large storage and exchange to the atmosphere and infrequent runoff at a regional scale. This contrasts wetland hydrologic units which contribute most frequently to regional scale runoff due to low soil storage and persistent lateral surface or near surface runoff. Mapping the organization or configuration of these two hydrological (or cryptic) units on distinct geologic landforms rather than the topographic drainage networks appears to best represent water cycling and interactions in the WBP. Using cryptic units will facilitate better understanding and modeling of regional runoff and aid in determining the influence of geology, climate and land use interactions in heterogeneous glacial landscapes.