H32C MCC: Level 1 Wednesday 1330h

Assessing the Impacts of Vegetation on the Water Balance I Posters *(joint with B)*

Presiding: **B R Scanlon,** University of Texas at Austin**; M A Walvoord,** U.S. Geological Survey

H32C-0579 1330h POSTER

Use of Satellite-Based Precipitation Observation in Improving the Parameterization of Canopy Hydrological Processes in Land Surface Models

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Precipitation demonstrates significant spatial variability at scales much smaller than the typical size of a climate model grid cell. Lack of representation for such sub-grid scale variability in climate models causes severe errors in the simulated water balance over vegetated land. Here we address this issue by incorporating satellite-based precipitation observation data into land surface models. We first derive statistics of precipitation climatology on the basis of over three years of rain retrievals from passive microwave sensors aboard TRMM (TMI), DMSP (SSM/I) and other platforms. This information is then used to improve the parameterization of canopy hydrological processes in the Community Land Model. We will demonstrate the impact of observation-enhanced parameterization using results from two tropical regions, the Amazon and the tropical Africa. The errors caused by the lack of representation of sub-grid rainfall variability are most severe in these two regions because of the dense vegetation canopy and the dominant convective processes occurring in these two major continental convective chimneys.

H32C-0580 1330h POSTER

Rooting Dynamics and Soil Water Variation of Native Shrubs

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Understanding the relationships that exist in the soil-plant-atmosphere continuum in semi-arid areas presents particular challenges, requiring accurate quantification of soil water with depth, a highly variable and limiting parameter in these vulnerable ecosystems. Two sites in the Peanut Basin of Senegal were selected to study rooting patterns of native shrubs and the corresponding variation of water distribution within the soil profile in both the dry and wet season. During dry periods or dry spells in the wet season, soil moisture content (θ_v) surrounding the shrub's shallow roots is substantially moister than the adjacent soil matrix. It is therefore hypothesized, that nearing a condition of water stress, shrubs may participate in redistribution of soil water, effectively changing their own environment and enhancing their survival as well as that of neighboring annual crops. A possible region of water redistribution is interpreted to be between 15-75 cm depth, with the upper 0-15 cm remaining typically dry (θ_v < 1 m^{3}m^{-3}) and forming a self mulching mechanism protecting lower horizons from the intense evaporation, and the lower 75 to 105 cm depth acting as a "moist reservoir" ($\theta_v \sim 6$ m^{3}m^{-3}). We investigated shrub root depths, distribution, size, density and gravimetric soil water variation at 15 cm depth increments to 110 cm, and at 10 cm lateral spread increments to 200 cm from each shrub trunk. Shrubs exhibited a complex heterogeneous rooting system with approximately 50% of the root biomass occurring in the upper 30 cm and 95% in the upper 110 cm. Root study and soil moisture results are used to select optimal sensor placement in relation to shrub root depth and lateral spread extent. Monitoring is continuing for soil water and tension variation with sensors concentrated between 15 and 75 cm. Accurate quantitative data on the vertical and horizontal distribution of roots permits us to estimate how shrubs may alter water use by annual crops and modify water dynamics in this ecosystem.

H32C-0581 1330h POSTER

The Contribution of Deep Roots to the Water Cycle: Seasonal Patterns of Water Uptake and Hydraulic Lift from Below 7 m on the Edwards Plateau, Texas USA.

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The presence of plant roots in deep and shallow soil is potentially important for site water balance through water uptake and redistribution between compartments. However, direct measurements of water movement through deep roots are not usually possible. We used cave systems on the Edwards Plateau in central Texas to gain access to deep roots of Juniperus ashei and Quercus fusiformis between 7 and 20 m below the soil surface. Long-term sap flux measurements of J. ashei showed that a single large root measured 7 m below the surface contributed 20 - 50% of daily transpiration, depending on the water content of surface soils. During periods without rain, upward flow through deep roots was continuous during both day and night with nocturnal hydraulic lift contributing up to 20% of daily water movement from depth. Seasonal measurements of roots of Q. fusiformis drawing upon an underground stream 20 m below the surface showed a similar pattern. In both systems, sap flux through deep roots fell to zero during the night when the water content of surface soils was high following precipitation. As surface soil water content decreased, minimum flow rate through deep roots increased steadily before dropping back to zero when surface soil water content rose following precipitation. Our results show that these large woody trees play an important role in cycling water from depth in these karst systems.

H32C-0582 1330h POSTER

Assessing the Impact of Land Use on Groundwater Recharge in the Southern High Plains

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Although it is widely recognized that land use and land use changes can have a significant impact on the near surface water budget and groundwater recharge, field studies documenting the impact of land use on recharge are limited. The purpose of this study was to determine the role of land use on groundwater recharge using electromagnetic induction, soil physics (water content, matric potential head), and environmental tracers (chloride) in natural settings and cultivated (irrigated and nonirrigated) settings in the Southern High Plains in Texas. Eight boreholes were drilled and sampled to a maximum depth of 6 m in the study area. EM induction surveys were conducted in the vicinity of six boreholes using EM31 and EM38 meters. Recharge rates based on the chloride mass balance approach ranged from 0.1 to 28 mm/yr in the study area. Recharge rate variations correlated with land use: low recharge rates in natural sites (0.1 - 4 mm/yr) and much higher recharge rates in dryland sites (4 - 28 mm/yr). The time required to accumulate chloride was much greater in the natural sites (164 - 2767 yr) relative to the dryland sites (47 - 96 yr). Variations in estimated recharge rates are consistent with soil physics measurements: lower water content (0.06 - 0.08 g/g), low matric potential heads (-208 to -270 m), and generally upward gradients in natural sites and higher water content (0.08 - 0.13 g/g), much higher matric potential heads (-2 to -2.8 m) and downward gradients in dryland and irrigated sites. CMB recharge rates were highly correlated with water content that in turn was related to land use. Variations in depth-averaged apparent electrical conductivity monitored with EM31 and EM38 instruments were correlated with water content in natural and dryland sites (R = 0.97; $p < 0.01$) that, in turn, were related to land use. These results indicate that EM induction could be used in reconnaissance to map variations in water content in these settings, which is related to recharge. Results from this study area are consistent with measurements and monitoring in natural and irrigated settings farther north in the High Plains. Natural settings in these regions also have high chloride concentrations with bulge shaped profiles that require thousands of years to accumulate. Matric potential heads are also low and gradients are upward indicating upward flow over long periods. In contrast, irrigated sites have high matric potentials and downward gradients indicating wet conditions. Monitoring in the natural sites indicates no change in matric potential head below the shallow subsurface whereas monitoring in irrigated sites shows downward drainage below the root zone. These field studies indicate that land use plays an important role in controlling recharge in the Southern High Plains and cultivation and irrigation have greatly increased recharge.

H32C-0583 1330h POSTER

Evaluating Climate, Vegetation, and Soil Controls on Groundwater Recharge Using Unsaturated Flow Modeling

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Understanding the relative importance of climate, vegetation, and soils in controlling groundwater recharge is critical for estimating recharge rates and for assessing the importance of these factors in controlling aquifer vulnerability to contamination. Understanding the role of climate and vegetation in controlling recharge will also be valuable in determining impacts of climate change and land use change on recharge. Numerical modeling is a valuable tool for assessing controls on recharge and for developing a predictive understanding of recharge processes. Unsaturated flow modeling was used to simulate recharge for a range of climate (arid - humid), vegetation (shrub, grass, forest, crops), and soils (fine - coarse grained, monolithic - layered) using data from Texas. Data from 10 meteorological stations in the state provided long-term (30 yr) climate forcing ranging from arid to humid conditions. Spatial distribution of dominant vegetation associations provided by the USGS was used to assign vegetation parameters using GIS and including fractional vegetation coverage, leaf area index, root depth, and root length density. Varying levels of soils data were used in the simulations ranging from simple monolithic sand profiles to complex layered soil profiles from the SSURGO database and pedotransfer functions were used to translate soils data to hydraulic parameters for the simulations. The effect of climate was evaluated using monolithic sand profiles without vegetation. Recharge rates varied from 54 mm/yr in arid west Texas to 720 mm/yr in humid east Texas, correlating positively with precipitation (R=0.99, slope = 0.69). These recharge rates represent 24 to 61 percent of long-term average precipitation. High potential recharge rates in monolithic sand profiles indicate that climate is not the limiting factor controlling recharge and that vegetation and soil texture are important in reducing recharge. Addition of vegetation to the monolithic sand profiles reduced recharge rates for most cases by factors ranging from 2 to 11. Soil profile layering reduced recharge rates in most cases relative to recharge rates based on monolithic sand profiles by factors ranging from 2 to 10. Recharge estimates based on nonvegetated, layered soil profiles were quite variable locally depending on soil texture and sequence of layers. However, aerially weighted average recharge rates for the counties analyzed in this study were much less variable and were positively correlated with precipitation (R=0.79; slope = 0.19). The final simulations included vegetation and layered soil profiles and resulted in recharge rates ranging from 0 to 328 mm/yr which represent reductions from potential recharge by factors ranging from 6 to 380. Unsaturated flow modeling proved to be a useful tool in evaluating the effects of climate, soil, and vegetation on recharge because these factors could be isolated in different simulations. Modeling results indicate that long-term average precipitation can be used as a predictor of recharge, but is not the limiting factor; vegetation and soil texture are important in reducing recharge. The results of this study have important implications for estimating recharge and indicate that the role of vegetation and soil texture in reducing recharge could significantly impact aquifer vulnerability to contamination.

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H32C-0584 1330h POSTER

Impact of Fire on Recharge at a Semiarid Site

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The potential hazards and benefits of fire are critical issues in semiarid parts of the Western USA. The hydrologic impacts of fire, in terms of recharge, are poorly understood in the region. These impacts depend largely on the transpiration of the newly established, post-fire vegetation relative to that of the pre-fire vegetation. In this study we focus on two impacts of fire on vegetation, the reduction of leaf area index, which influences the rate of transpiration, and the potential reduction in effective rooting depth, which influences the amount of water transpired. The study site has a mean annual precipitation of about 550 mm with a native vegetation dominated by semiarid shrubs. For one season prior and one season following a prescribed fire we monitored leaf are index, soil water content, and soil water potential in adjacent burned and unburned plots. One year after the fire we have documented a substantial reduction in leaf area index and effective rooting depth. Simulations indicate that potential recharge after the fire increased by more than 50 mm per unit area. This result will vary considerably with location depending on environmental factors such as the soil depth and amount and season of precipitation.

H32C-0585 1330h POSTER

Hypothesized Hydrological Response to a Prescribed Fire on a Small Mountainous Watershed

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Prescribed fire is often used to control invasive weeds, improve habitat, and deter wildfire. The USDA-ARS Northwest Watershed Research Center plans to burn a small 26-ha ephemeral watershed where detailed measurements and a ten-year water balance had been conducted. This paper investigates the potential hydrological response to that prescribed fire. Changes in water repellency and infiltration capacity were assumed not to limit the low intensity snowmelt input to the basin. Percolation, subsurface flow and runoff during the first runoff season are influenced by the soil moisture deficit created by pre-burn vegetation conditions and will likely not be influenced greatly by the fire. A year of reduced evapotranspiration following the fire is necessary to significantly reduce the soil moisture deficit and increase percolation through the root zone and subsurface flow to the stream. Results indicate significant changes in streamflow in this subsurface-flow-dominated watershed may not be observed until the second snowmelt season following the fire and could increase by approximately 25%. These results are unlike watersheds dominated by overland flow and surface runoff where increased flows are more likely to occur during the first year following a fire.

H32C-0586 1330h POSTER

Impacts of Prescribed Burning in Upland Meadows on Understory Evapotranspiration

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The frequency and extent of prescribed burning is increasing in Southwestern forest and meadow ecosystems. This management action has the potential to impact groundwater recharge. We are studying the impacts of prescribed burning on evapotranspiration of the herbaceous understory in an upland wet meadow at Hart Prairie, Arizona. Three treatments (non-burned control, burned during the early-summer pre-monsoon season, burned during the late-summer monsoon season) were randomly applied to replicated circular plots (2 m radius) in each of two herbaceous communities (grass dominated, fern dominated) in 2001. Treatment effects on herbaceous evapotranspiration were assessed by soil-water budgets based on repeated soil-moisture measurements with time-domain reflectometry. In 2001, the pre-monsoon burn increased soil-water content in the grass-dominated community, and to a lesser degree in the fern-dominated community, compared with the control. In 2002, one summer after treatment, both pre- and post-monsoon burns decreased soil-water content compared with the control, with a larger decrease occurring in the fern-dominated community. These trends in soil-water content continued in 2003, two summers after burning. Reduction of evapotranspiration caused by the pre-monsoon burn increased soil water available for groundwater recharge for several weeks following treatment. However, the beneficial effect of burning on groundwater recharge was short-lived as herbaceous evapotranspiration was higher in burned compared with non-burned plots one and two years after treatment.

H32C-0587 1330h POSTER

Covariability Found in Evapotranspiration and Satellite-derived Vegetation Index Interannual Change Over Northern Asia

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The transpiration from the vegetation of extensive forests plays an important role in the water and energy cycle in the climate system. We reported that the continental scale evapotranspiration (ET) shows similar interannual change with that of the satellite-derived Normalized Difference Vegetation Index (NDVI) from 1982 to 2000 (Suzuki et al., AGU 2002 fall meeting). This study develops it by examining ET interannual change over northern Asia, and comparing with two essential climate parameters, temperature and precipitation, in addition to the NDVI . Monthly global NDVI data were acquired from the Pathfinder AVHRR Land data (1 $\times$ 1 degree). The ET was estimated by so-called "atmospheric water budget method, " that is, a method for estimating the ET from the precipitation and water vapor divergence in the air column on each grid cell. This study used 2.5 $\times$ 2.5 degree spatial resolution atmospheric data created by the National Centers for Environmental Prediction, and gridded (2.5 $\times$ 2.5 degree) precipitation data provided by the CPC Merged Analysis of Precipitation. Temperature data are obtained from CRU TS2.0 dataset which consists of monthly gridded (0.5 $\times$ 0.5 degree) value based on the surface station observation. The monthly anomaly of the NDVI, ET, temperature, and precipitation was calculated for each 2.5 $\times$ 2.5 degree grid cell from 1982 to 2000, and year-to-year variation of the ET was compared with other three parameters. In addition to the significant positive correlation between the ET and NDVI interannual changes, high positive ET-temperature and ET-precipitation correlations were seen in summer mainly over northern low-temperature areas of Siberia and over arid areas to the south of 60°N, respectively. Since the highest ET-NDVI correlation was found in June when the vegetation in the area is most active, it is considered that the primary factor for the ET interannual change should be vegetation interannual change. However, the strong correlations in ET-temperature and ET-precipitation suggest that these two climate factors have a significant relation to the ET interannual change in addition to the vegetation. This result will be a lead to reveal the relationship between the climate-vegetation system and its influence on the ET.

H32C-0588 1330h POSTER

Irrigation Induced Changes in Areal Evapotranspiration in Southeastern Turkey: Test and Application of Bouchet's Complementary Relationship

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Recent study using satellite data in Southeastern Turkey reveals that irrigated lands have expanded up to 300 percent over the course of ten years. Such large-scale expansion of irrigation is expected to have had a large influence on the regional hydrologic cycle by significantly altering evaporating conditions. However, to date, the existence and the magnitude of such modifications largely remain unknown. To quantify such impacts, we used statistical analysis of long-term meteorological observations as well as models of evaporation specifically suited to changing soil moisture supply, all within the context of Bouchet's complementary relationship. The hypothesis of complementary relationship states that over a large homogeneous surface is negligible, the actual areal evaporation and the potential evaporation are in a complementary relationship, provided the energy balance of the surface remains constant. This hypothesis could provide the tools to quantify irrigation induced changes in partitioning of water between the land surface and the atmosphere. As well, it provides the appropriate tools to calculate actual evaporation based on routine meteorological observations. To determine whether pronounced changes in evaporating conditions due to large-scale irrigation exist within a large agricultural plain in semi-arid Southeastern Turkey, we used 27-year seasonal meteorological observations of temperature, humidity, wind speed, and radiation within the framework of complementary theory. Results indicate that the potential evaporation has decreased from about 10 mm/day to about 5 mm/day, closely following the increase in irrigation over the same period. This decline in potential evaporation is a result of a decrease in wind speed and increase in humidity. These results indicate that the rapid expansion of irrigation in Southeastern Turkey has strongly modified the lower atmosphere in a way that appears consistent with Bouchet's complementary theory. Future work will include quantification of actual evaporation as a function of irrigated land area using both observational data and results from simulation analyses with a meso-scale climate model.

H32C-0589 1330h POSTER

Hydraulic, Vegetation and Water Quality Characteristics of Heavily Vegetated Groundwater-Fed Ditches in a Riparian Peatland in Northern Germany

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The Environmental Ministry of Schleswig-Holstein (Northern Germany) has implemented a novel peatland management strategy in order to use the high nutrient retention potential of degenerated wetlands and peatlands, and to improve the habitat conditions at the same time. The effect of raised water levels and passive land use management on hydraulic properties and water quality of heavily vegetated and groundwater-fed ditches at one nationally important wetland case study at the Eider River valley was investigated. Most ditches in the Eider River valley were small and overgrown. The flow properties of selected ditches were regularly assessed at different discharge levels during different vegetation cover periods. The hydraulic residence is predominantly a function of the ditch geometry and overall obstruction cover including the presence of macrophytes. Vegetation cover and other hydraulic obstructions such as accumulated silt and organic debris slow down the hydraulic residence time and lead to a change in the water quality along the ditch. Experimental results were evaluated to get more realistic values for total bed-roughness and pollution loading under different hydraulic flow regimes. The total-roughness K_m values of both vegetated and excavated ditch stretches were about 1 and 10, respectively. However, K_m is actually a crude "fudge factor" depending predominantly on the hydraulic radius rather than on the total-roughness. This is in contrast to the theory presented in the literature. The biochemical oxygen demand and nutrient concentrations of 24 ditches were analyzed. Mean biochemical oxygen demand, ammonia, nitrite, nitrate and ortho-phosphate concentrations were 6.0 ($\pm$2.74), 0.2 ($\pm$0.44), 0.0 ($\pm$0.02), 1.6 ($\pm$2.04) and 0.0 ($\pm$0.02) mg/L, respectively. Elevated biochemical oxygen demand and nitrate concentrations for upstream ditch cross-sections were apparent.

H32C-0590 1330h POSTER

Small scale variations in soil depth affecting the patterns and relationships between soil moisture and transpiration

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Relations between the spatial patterns of soil moisture, soil depth, and transpiration and their influence on the hillslope water balance are not well understood. When determining a water balance for a hillslope, small scale variations in soil depth are often ignored. In this study we found that these variations in soil depth can lead to distinct patterns in transpiration rates across a hillslope. We measured soil moisture content at 5-10 cm depth intervals between the soil surface and the soil-bedrock boundary at 64 locations across the trenched hillslope in the Panola Mountain Research Watershed. We related these soil moisture data to transpiration rates measured in 16 trees across the hillslope using 32 constant heat sapflow sensors. Results showed a lack of spatial structure in soil moisture across the hillslope and with depth when the hillslope was in either the wet or the dry state. However, during the short transition period between the wet and dry state soil moisture did become spatially organized with depth and across the hillslope. Variations in soil depth and thus total soil water in the soil profile at the beginning of the growing season caused differences in soil moisture content and transpiration rates between upslope and midslope sections at the end of the summer. In the upslope section, which has shallower soils, transpiration became severely limited by soil moisture while in the midslope section with deeper soils transpiration was not limited by soil moisture. These spatial differences in soil depth, total water available at the beginning of the growing season and soil moisture content during the summer could be responsible for the observed spatial differences in basal area and species distribution between the upslope and midslope sections of the hillslope.

H32C-0591 1330h POSTER

Influence of Near-Surface Vegetation on the Values and Variability of Soil Water Content

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Shallowly rooted vegetation can have a significant influence on the water content of near-surface soils. In precision agriculture applications, shallowly rooted crop cover is often used to modify the natural soil water content to produce optimal moisture conditions for the primary crop. In this study, the influence of crop cover on shallow soil moisture at a 3-acre California vineyard with heterogeneous soil textures was investigated using estimates of soil water content obtained from ground penetrating radar (GPR) measurements. The vineyard was planted with grapevines in rows separated by 1.2 m, and shallowly rooted crop cover (zorrow fescue grass) was planted in alternate rows between the grapevines. The shallow soil water content was estimated across the vineyard under varying conditions of precipitation and irrigation and at two depths. Water content estimates were produced from very high-resolution GPR data collected along selected rows, providing a very detailed data set (20,000 measurements) of the water content in rows with and without crop cover. Analysis of these data showed that crop cover can significantly alter both the absolute values and the variability of the shallow soil water content, especially for data collected under drier conditions. Comparison of measurements collected at two different depths also showed that the effects of crop cover varied with depth, with the greatest influence exerted in the very near-surface soils. Rows planted with crop cover typically had a lower average water content than rows without crop cover, except under very wet conditions. The variability of the near-surface water content was investigated by calculating variograms for rows with and without crop cover and for all rows considered together. These variograms showed that rows with crop cover typically had lower variability than rows without crop cover, and that the influence of crop cover on soil water content variability was also dependent on the absolute value of the soil water content.

H32C-0592 1330h POSTER

Hydrologic Impacts of Climate Variability and Land Use in Africa

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The hydrologic cycle in the semi-arid regions of Africa is highly variable. Sustainable water resource management requires the assessment of the hydrological impacts of climate variability and land use changes. As part of a larger study we are using two numerical models the Integrated BIosphere Simulator (IBIS) and the Hydrological Routing Algorithm (HYDRA), to investigate the relative impacts of the three major determinants of the observed changes in terrestrial hydrology in Africa: (1) climate variability, (2) land use, land cover change, and (3) water management practices. Based on both historical climate fluctuations and hypothetical scenarios, this study focused on addressing how climate variation and land use changes affect the hydrologic regime in Lake Chad Basin and Niger River Basin, including (a) hydrologic sensitivity and vulnerability to climate fluctuations; (b) hydrologic response to a variety of scenarios of temperature increases and precipitation increases or decreases; and (c) hydrologic impacts of different vegetation types and land use scenarios. Possible future hydrological regimes and consequences of the existing climate variability and land use practices were also discussed.

H32C-0593 1330h POSTER

Water Balance in a Mid-Latitude, Mixed Grass Prairie

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Covering more than 50,000 square kilometers, the Nebraska Sand Hills are the largest stabilized dune field in the world. A unique feature of this region is the close proximity of the land surface to the vast High Plains Aquifier. The land-surface is classified as a mixed grass prairie, and except for a few very small instances, has never been put under the plow. The region is currently home to most of the rangeland cattle industry in Nebraska, and prior to European settlement, was the primary home-range for large herds of North American bison. The co-location of an extensive sub-surface water resource and an inherently semi-arid climate produces an interesting ecosystem, which affords many unique opportunities to study plant-water relationships. We are currently operating a pair of Energy Balance/Bowen Ratio (EBBR) systems to measure evapotranspiration and other ecosystem parameters within key land surface types. We now have 2 growing seasons or more than 20 months of data. We will discuss this data and compare the two seasons in terms of water inputs and outputs.

H32C-0594 1330h POSTER

How Does Canopy Structure Influence Interception and Canopy Storage of Rainfall in Young and Old Douglas-Fir Forests?

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To predict the canopy storage, interception loss and throughfall of rainfall under a forest some modelers have relied on the leaf area index (LAI). However, the use of LAI may not be applicable in old growth forests in the Pacific Northwest because they frequently have complex canopies that are heavily populated with epiphytes. These epiphytes may increase the storage and interception loss of rainfall in old growth forests relative to young forests because of their ability to store many times their mass in water. To investigate the effect of canopy structure on canopy hydrology, we compared and contrasted the interception loss, throughfall and spatial variability of rainfall in a young (24 year-old) and an old (>450 year-old) Douglas-fir forest with very similar LAI (LAI = 10 ±1 young; = 9.6 ±0.5 old) in the Pacific Northwest (Wind River Canopy Crane Research Forest, South-central Washington, USA). Rainfall was monitored using an array of tipping bucket rain gauges (25), and PVC rain collectors (50). We found that young forests have one third the canopy storage (young - 1.10 mm; old growth - 3.32 mm) and direct throughfall (young - 0.1; old growth - 0.36) relative to the old growth stand even though they have a very similar LAI. Furthermore, the spatial distribution of rainfall beneath the old growth stand was skewed with many locations below the canopy receiving more precipitation than above the canopy. Hence, it may not be applicable to use LAI to predict canopy variables in old growth Douglas-fir forests.

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A methodology for predicting the impact of vegetation on flow duration curves

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While the impact of vegetation on the mean annual water balance is well understood, there is a need to be able to predict the impact of vegetation changes on the magnitude and frequency of daily flows. A flow duration curve (FDC) displays the relationship between any given flow and the percentage of time that flow is exceeded. This paper provides a method for linking the current understanding of the impact of vegetation on the mean annual water balance to changes in the daily FDC. The FDC is described by five parameters, the conditional median (median flow for days when flow exceeds a given threshold), the cease to flow percentile and three curve fitting parameters. The parameters of FDC model are then linked to a mean annual water balance model using daily rainfall data, thus allowing the FDC to be adjusted to changes in vegetation. Two methods are proposed for linking the mean annual water balance model to the FDC model. The first method is appropriate for gauged catchments where daily flow data under existing vegetation are available (i.e. the FDC under current conditions is known). The second is appropriate for ungauged catchment and relies on the regionalisation of the FDC model parameters. The gauged catchment method has been tested on data from 16 paired catchment studies. These catchments are generally small head water catchments and provide an excellent source of data for catchments undergoing large percentage changes in vegetation. The regionalisation of the FDC model parameters is based on data from 23 catchments in the upper and middle Murrumbidgee basin, NSW, Australia. These data were divided into calibration and validation data sets. The calibration data set was used to develop regional relationships, while the validation data set tested how well these regional relationships predicted the observed FDCs under current vegetation conditions. The methodology for the gauged catchments was able to replicate the observed changes in FDC for the paired catchment studies and is considered appropriate for the adjusting a known FDC for changes in vegetation. The regionalisation of the model parameters revealed the sensitivity of the FDC model to the predictions of the conditional median and the cease to flow percentile. The results of the regionalisation indicate the further work is required to improve the regional predictions of the FDC model parameters, particularly the conditional median.