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The Water Balance

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The water balance is the statement of the conservation of mass within the hydrologic or water cycle, where a change in internal moisture storage is balanced by moisture fluxes into and out of an area of interest. Over long, stationary time periods, that is, multi-year periods with little to no change in the mean behavior of the hydrologic system, the field-scale water balance describes how precipitation results in fluxes such as surface runoff, drainflow, groundwater recharge and evapotranspiration. The mean annual water balance is an essential tool both for estimating components that cannot be measured directly (e.g. groundwater recharge) and for validating field measured values (e.g. is measured annual drainflow less than annual precipitation). Evapotranspiration represents the largest outflow component of the long-term water balance, approximately 2/3rds of precipitation, but it is also one of the most difficult to measure. The watershed-scale is the fundamental scale for water balance calculations, since lateral outflow components, including surface runoff, drainflow and groundwater discharge can be captured at one streamflow monitoring location.

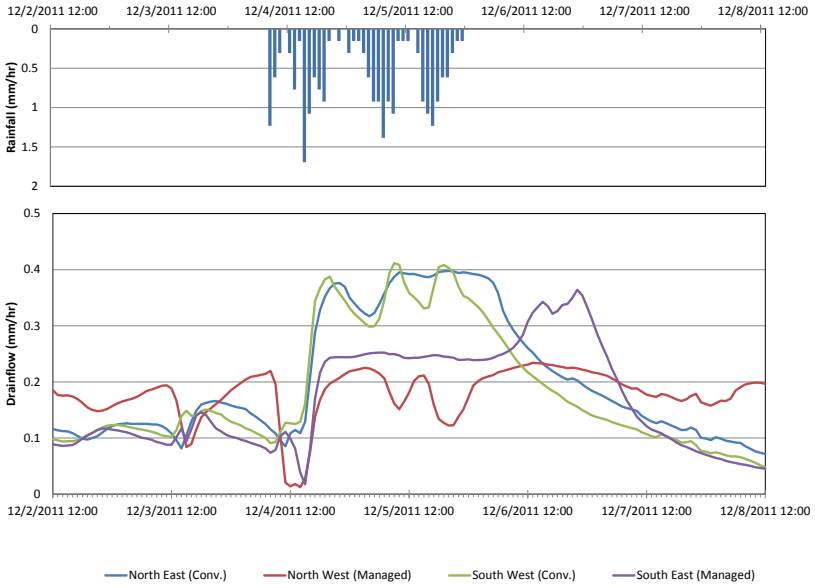
During periods of change (non-stationarity) due to short time variations (e.g., seasonal differences in precipitation), or long term environmental changes, the change in storage terms that balance the inflow and outflow terms become more important. For example, increasing precipitation intensity can result in the generation of more surface runoff, decreasing the positive change in soil moisture associated with rainfall events. Storage of snow and soil ice decreases during warmer winter periods, increasing winter surface runoff, drainflow and groundwater recharge relative to historic periods and changing historic soil moisture and temperature values at the start of the growing season. The interconnectivity of water cycle fluxes and storage terms represented by the water balance mandates a comprehensive monitoring and analysis approach to increase understanding of future agricultural water sustainability.

Surface runoff, Tippecanoe County, IN

Drainage monitoring installation, DPAC Site, IN

Surface drainage ditch, Tippecanoe County, IN

Piezometers to monitor ground water levels, IN



Observed water balance data for the Davis Purdue Agricultural Center field site in December 2012, where the primary inflow term, precipitation (top), is reflected in the primary outflow term, drainflow (bottom). For an isolated field, we expect precipitation to exceed drainflow over annual intervals, but, over one hour measurement intervals, the temporary storage and release of moisture in the soil can allow drainflow rate to exceed precipitation rate.

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