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Comparing runoff characteristics between an evergreen cypress forest and a mixed-broadleaf forest during different phenological periods in central Japan

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Understanding baseline runoff characteristics is critical in any water balance study whether single- or multiple-catchment. As a product of interaction between many area-specific factors (scale, climate, geology, vegetation, land-use history), each catchment can only be well-understood through a reasonable period of baseline observation. In temperate regions, processes are complicated by a range of meteorological factors and plant phenological periods (growth and dormant) as well as the way vegetation reacts to these factors resulting in varying water uptake from soils. In the Inuyama Research Forest of the Ecohydrology Research Institute in Aichi prefecture, central Japan, streams in two small headwater catchments (cypress plantation, 2.2 ha; secondary mixed-broadleaf, 2.1 ha) were instrumented with 90° v-notch weirs and automatic data loggers that recorded water level at 5-minute intervals. These data were then converted to discharge via calibration. A weather station was also set up in the area to record rainfall and other meteorological data. After quality control and data filtering, 1,398 daily runoff and rainfall over five years (April 2013-April 2018) were computed and analysed. Data were separated according to plant phenology (growth period from 1st May to 31st October; dormant period from 1st November to 30th April) and explored via runoff coefficients (C) and rainfall-runoff regressions in two ways:- (i) growth vs. dormant periods within individual catchments (cypress and broadleaf); (ii) cypress vs. broadleaf forests within each phenological period (growth and dormant). C-values in the growth and dormant periods are 0.534 and 0.521 for cypress; and 0.506 and 0.525 for broadleaf respectively. Within individual catchments, the cypress catchment has a 2.5% higher C-value in the growth period (0.534) compared to in the dormant period (0.521) whilst the broadleaf catchment shows a 3.6% reduction instead (0.506 in growth; 0.525 in dormant). This suggests that during the warm and humid growth period, the increased water uptake by cypress trees does not offset the influence exerted by higher rainfall. However, the slopes of rainfall-runoff relationship are higher during the growth period in both catchments. For comparison between the two catchments within the same phenological period, the 5% lower C-value in broadleaf (0.506) compared to cypress (0.534) reflects higher water use by broadleaf trees during the growth season whereas similar values (0.521 in cypress, 0.525 in broadleaf) during the dormant season indicate continual rainfall interception by cypress even after leaf abscission in the broadleaf catchment. This is further supported by the higher slope of rainfall-runoff relationship in the broadleaf catchment during the dormant period. This study has shown that rainfall-runoff relationships in this area differ according to vegetation type and phenological periods. Hence, forthcoming catchment hydrological studies should be designed to control for these effects.