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RAINFOREST CONVERSION TO ANNUAL CROPPING AND COCOA PLANTATIONS IN MONTANE SULAWESI (INDONESIA): IMPACTS ON SOIL HYDRAULIC CONDUCTIVITY AND IMPLICATIONS FOR RUNOFF GENERATION

REGENWALDRODUNG FÜR ANNUELLE KULTUREN UND KAKAOPLANTAGEN IM MONTANEN SULAWESI (INDONESIEN): KONSEQUENZEN FÜR DIE GESÄTTIGTE HYDRAULISCHE LEITFÄHIGKEIT UND ABFLUSSBILDUNG

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SUMMARY

Conversion of natural forest to annual cropping is generally accompanied by major changes in soil physical attributes, including saturated hydraulic conductivity (K_{sat}), with potentially important consequences for rainfall partitioning at the surface, dominant flow paths, and runoff generation. We measured K_{sat} at three depths (0.15, 0.30 and 0.60 m) beneath different land-use types using a Guelph well permeameter in a rainforest catchment in Central-Sulawesi (Indonesia), where forest conversion to annual cropping and cocoa plantations has occurrred since 1999. Ten transects were selected within the 2.6 km^2 catchment to represent the main land-use types. Spatial variability in near-surface K_{sat} was high for all land uses. Two major land-use groups having significantly different K_{sat} at 0.15 m depth could be distinguished, reflecting contrasting management intensities. Natural forest and extensively used cocoa plantations had median K_{sat} values of 173-265 mm h^{-1}, whereas intensively used cocoa plantations, pasture and cropland had an overall median value of ~6 mm h^{-1}. The contrast in near-surface K_{sat} values for extensively used cocoa plantations (medians of 129-216 mm h^{-1}) and intensively used plantations (4-45 mm h^{-1}) indicates that for a given land use, the duration of cultivation and the intensity of management are important factors in the decline of K_{sat}. Median K_{sat} decreased by an order of magnitude with depth from 0.15 m to 0.30 m, regardless of land-use type. Although comparison of K_{sat} profiles with prevailing rainfall intensities suggested percolation in the dominant soil type (Cambisol) was predominantly vertical, perched water tables were inferred to develop at 0.15 m and 0.30 m depth for 33-35 % and ~54 % of total rain-time, respectively, in the intensively managed land-use group. Perched water tables were inferred for a very similar fraction of total rain-time (33-35 %) at 0.30 m depth in the extensively managed group as well, but not at 0.15 m depth. Volumetric soil moisture contents at 20 cm depth exceeded field capacity on 28 %