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Shortcomings of Horton-Strahler ratios and definition of new equivalent ratios for the derivation of the Geomorphological Instantenous Unit Hydrograph

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The Horton-Strahler ratios (R_B, R_L and R_A) have been used to compare catchments and to identify the Geomorphological Instantaneous Unit Hydrograph (GIUH, Rodríguez-Iturbe and Valdés, WRR 1979). However, they have also attracted criticism because of their extreme sensitivity to the resolution of the initial elevation data. The most common approach to extract channel networks from DEMs consists in specifying a threshold Area 'S', usually assumed constant, which is the minimum drainage area for a channel to form. It is recognized that different threshold areas will result in substantially different channel networks and hence different Horton-Strahler ratios. The second problem concerns the basin order because consideration of the whole basin as a 'mature' catchment of order Ω is often misleading. What often happens is that the basin outlet is little downstream of a junction of two sub-basins of order Ω-1. In these cases the basin is not really representative of a fully developed network of order Ω, and this affects the value of Ωtlength and Ω-area order, and consequently the estimates of the Horton-Strahler ratios. The third problem arises because the natural basins analysed in the literature seldom have Horton-Strahler orders greater than 5; this leads to just a few numbers of ratios with discontinuities while the drainage network is a continuous set. To overcome these limitations, we propose a new set of indices, equivalent to the Horton-Strahler ratios and independent of S, yet respecting the self-similarity properties of the channel network structure. Applications are conducted on seven basins located in Southern France with areas ranging from 800 to 2600 km^2. First, we define morphometric properties of the channel network topology

independent of S. Then, we compare them to the Horton-Strahler ratios (R_B, R_L and R_A). Finally, these new equivalent ratios are applied to calculate a GIUH independent from S. The results indicate that the new ratios have the same morphometric properties of the well known Horton-Strahler ratios and can be used in all applications instead of the classical Horton-Strahler ratios.