Comments to the Authors:

The work proposed by Dr. Yang, Dr. Choi, and Dr. Paik investigates the power-law (PL) relationship between the pruning area and the drainage density. The work's theoretical flavor does not lack in application, since it is applied to several rivers in the US as case studies. The overall impression of the work is good, whereas it can be improved in some parts and might benefit from further analysis. Major comments are itemized in the order of the manuscript's sections.

- L. 20-25: the literature-based explanation of the relationship between drainage density and climatic conditions of catchments can be elaborated a little bit more, e.g. providing further explanation about how L_T increases at the decrease of A_0, and vice versa.
- General comment: you could provide a 2-panel Figure with sketched two kinds of basins for a prompt (visual) appraisal of the involved variables, in particular A_0 and A_p. They can be drawings of two different catchments you investigated, or just two exemplary (not real) ones, or again a sketch representing two catchments one upstream and one downstream of the same river.
- Figure 1 and lines above: the usage of 5 climatic regions in the US is forgotten in the rest of the manuscript. It seems that the networks, which are then investigated in their PL behaviors, are not related to the climatic region they are located anymore after Figure 1.
  Thus, there are two choices: 1) you can make the US Figure smaller and surround it (e.g. in enlargements) with as many Figures as the catchments you provide in Figure S1, and referring to climatic areas to generally frame these catchments and their overall climatic (hence precipitation? Please specify) conditions; 2) (I suggest this one) you can make a more impactful use of these climatic regions. For example, you can make a boxplot chart by classifying all the apparent drainage densities by climatic region. See, as an example, the classification of salinity values for depositional environments done by Schiavo et al. (2023) (Figure 5). If you choose to go down for keeping the subdivision in climatic zones of the US territory and therefore this influence on networks' structure, you should provide a classification of all the required exponents for all 5 climatic areas (see the following points).
- Figure S1: do all the DEM have the same spatial resolution? If yes, it's ok; if not, you should homogenize the meshes before employing any routing algorithm. Rigon et al. (1996) and Maritan et al. (2002) correctly underlined the multi-scaling problem when treating DEMs at different resolutions.
- Figure 2a: it is not clear to me which are the values of the 3 thresholds employed for discretizing the x-axis, i.e. the pruning area variable; they seem to be about 0.02, 0.5, and 3 km^2, respectively. How did you choose them? Could you report the numerical values and motivations (if any) you employed for these choices?
- Figure 2a: it would be nice to further discuss the PL relationship of each trait of the 3 portions you identified, i.e. values of apparent density for $A_p<0.02$, $0.02<A_p<0.3$, and $A_p>0.3$ (see e.g. D'odorico and Rigon, 2003). In other words, to offer results for the first, middle, and tail traits of the power-law relationship proposed in Figures 2a and 2b. This aspect would be very interesting to widen the investigation to the pruning area-apparent density relationships not only in the whole branch, but in each upstream, medium, and downstream trait. It also would provide a stronger confidence interval for estimating PL'exponents. Then, you'd come up with 4 exponents for each n=1,14 network, each exponent referring to a different portion of the network (like $\eta 1$, $\eta 2$, and $\eta 3$), and the 4th for the "whole" one (η, you already did this).
- Figure 2b: please comment on the impact of the threefold classification of PLs upon the variability of apparent density under varying pruning areas. These three kinds of exponents allow you to better investigate the behavior of the plot you give in this figure. Indeed, the 1st trait is constant, and the other two are sloping. Please comment adequately, also referring to each network portion's total area and branching structure.
- Figure 3: can you give the correlation coefficient of all those exponents obtained upon the (24) and those with the (25) to quantify the correlation discrepancies? Moreover, could you provide the other 3

panels of the same Figure by plotting η1, η2, and η3 in the same way (and with them correlation coefficients)?

- Flow routing method: the choice of the D8 flow method is not adequately supported. Indeed, it has been probably (implicitly?) chosen concerning the DInf or other ones because D8 guarantees the maximum energy (local) dissipation (e.g. in Schiavo et al. (2022)) by always following the steepest descent. Please clarify this point, eventually referring to Schiavo et al. (2022), for a complete thermodynamic framework (please elaborate on these concepts a little bit) of the processes you are investigating.

Once all these points are solved, I consider the paper interesting and innovative, and worthy of being published in such a prestigious journal. Best regards,

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