Prof Nunzio Romano

HESS, Editor

Dear Nunzio,

Thank you and the reviewers for reviewing my paper. I revised the paper (especially Sec. 3 and the related Appendices) following the reviewers' recommendations, which helped improve the paper. The detailed of the response are in the following pages.

I remain at your disposal for any further changes. Sincerely,

Amilcare

Referee 1

I am very grateful to referee 1 for the nice comments and positive assessment about the paper. In the revised version, I've added a comment regarding the cases in which the dimensions are not easy to define, as in problems interfacing with social and economical components.

Referee 2

I thank the referee 2 for his/her nice comments and friendly advice on the paper. I've revised the paper to include these suggestions. In particular, in the introduction and conclusions, I have commented on the fact that the physical law, as a starting point of the dimensional analysis, should be kept as simple as possible exactly to avoid the problem mentioned by the reviewer of ending up with too many dimensionless Pi groups.

Secondly, I've modified and improved the presentation in Sec. 3. This is also in response to Ref. 4, who also had useful suggestions about that Section of the paper. I've now added an appendix (B) on the derivation of the governing equations for the landscape evolution model as well as one (Appendix C) on the analogy with near wall turbulence.

Referee 3 (Demetris Koutzoyiannis)

I would like to thank professor Koutzoyiannis for a very nice and useful review.

With regard to his main points, i've now improved the presentation of self-similarity in the discussion of the Rayleigh-Riabouchinsky controrversy and explained that indeed there is nothing a priori in the function \varphi that would lead to the fact that the smallness of the second Pi terms does not count in the overall function. As correctly stated by the reviewer, it is a matter of experience, an empirical fact, that leads to this emergence of themrodynamics neglecting the disorderly degrees of freeedom of molecular motion.

I've also improved the presentation of Sec. 3 and added the reference to the paper by Theodoratos et al. (2018).

I've commented on the fact that the scaling laws obtained with self-similarity assumptions are only asymptotic, as also mentioned in the paper by Koutzoyiannis et al. (2018), which is now cited in the conclusions. The orginal paper by Kolmogorov is now also cited.

Finally, I've corrected the typos that were kindly pointed out and added a footnote to the title, mentioning that this paper is related to the Dalton-medal lecture. Thank you!

Referee 4 (Stefan Hergarten)

Many thanks to professor Hergarten for his kind review and positive criticism. I have considered seriously his comments and followed them to improve the paper, especially Sec. 3.

In particular, regarding the units of the scaling laws (1) and (2), I've added a footnote to explain that in mathematics it is common to refer to dimensionless quantities. This is because the arguments of transcendental functions have to be dimensionless anyway (Barenblatt, 1996). Here however, since we are explicitly talking about dimensions, it is important to remember that this implies the presence of dimensional unit factors that make things consistent. Thank you for pointing this out.

Regarding the specific contributing area and the governing equations of LEMs, I've added Appendix B to better explain the derivation and meaning of this variable. The derivation from the surface water equation makes it clear that one needs a specific variable and not a global variable like A (contributing area, which is not defined at a point in a continuous representation. We hope that this is now clearer and that some of the confusion related to this issue is resolved. Thank you.