

## **Root zone in the Earth system**

**Hongkai Gao, Markus Hrachowitz, Lan Wang-Erlandsson, Fabrizio Fenicia, Qiaojuan Xi, Jianyang Xia, Wei Shao, Ge Sun, Hubert H. G. Savenije**

The authors highlight the importance of the root zone in different disciplines, reviewing the concepts that can be easily confused with it and the methods used to estimate it. Although I am convinced of the importance of understanding the processes occurring in the root zone to advance in the solution of a wide variety of problems of high research interest, I do not see a clear objective in this manuscript. The authors mentioned a possible confusion in defining the root zone but did not contrast them or show examples. Most importantly, they did not define the root zone clearly but posed many “root zone is not”. Besides, I did not find clearly which type of article this manuscript pretends to be since it is not detailed enough to be a review and is too general to be a perspective or opinion paper. In my opinion, the manuscript will be highly improved if the authors delineate the intention of the paper and focus on describing and discussing it. If the objective is to provide a unique and clear definition of the root zone, the structure and much of the information written in the manuscript could be inadequate. If the objective is to claim a holistic perspective for calculating the root zone, it should be better described this perspective and compared with the reductionist one. Moreover, I found several affirmations confusing, repetitive and not adequately referenced, and most of the figures were not well connected to the text. Please see below for more details.

### **Major comments:**

- The abstract does not include the results or conclusions of the manuscript. Having the "correct" definition of the root zone would be helpful.
- In the introduction, I expect more development of the need to clarify the definition of the root zone and the problems resulting from using different definitions.
- L116. Please explain Sumax better. What do the authors mean by “maximum water deficit in the root zone”? What is a maximum water deficit? Furthermore, it is not clear to me how this can happen when all the available water has been consumed after a critical period of drought. What is a critical drought period? I understand the water storage capacity as the volume of water that the root zone can contain (Rodríguez-Iturbe & Porporato 2004).

- L245-L247. It is not clear how the figure shows that. Consider numbering the different panels in the figure and associating them with what they are intended to indicate.
- L356. Is De Roo et al. The last quantification? It was made 30 years ago.
- L369. Is it possible to make this very general statement? Wouldn't the importance of the site and its conditions depend?
- L428-L429. What do the authors mean by "Changes in the root zone are generally cumulative, which may be introduced by slow, gradual or abrupt changes." Please be more specific.
- L437. Please elaborate in more detail why ecosystems can increase their Sumax while reducing tree cover.
- L455. Not in all cases, some ecosystems are currently emitting more CO<sub>2</sub> than they assimilate. Please provide references.
- L458. Please elaborate if carbon in the root zone has the greatest uncertainty, how is it possible to claim that it has a large influence on carbon neutrality and sequestration?
- L603. How large is the difference?
- Figures. In general, the figures show much more information than what is considered and described in the text. Their link and appearance in the manuscript do not seem clear to me.

### **Minor comments:**

#### **Abstract**

- Since this is a specialised magazine, I suggest eliminating the words in parentheses (water, soil, etc.). The same goes for the expression "water-centered perspective."

#### **Introduction**

- L72. Homogenize micro-biotic (microbiotic) and macro-biotic (macrobiotic).
- L87. What do the authors mean by "different reasons"? Please be more specific.

#### **Section 2**

- L98. Storage of water. Moisture is a relationship or ratio.
- L115. Why "reversely"?
- L120. Sumax is a variable, not a parameter.

#### **Section 3**

- L147. Is the root zone the only one that determines the ecosystem's resilience to droughts and climate change?
- L148. What about nutrient availability?
- L149. As it is a specialized journal, I do not think it is necessary to define "vegetation".
- L151-L156. Please provide appropriate references.
- L168. It is not necessary/possible to sample all trees. Isn't it better to compare in terms of species?

- L181. Please provide appropriate references.
- L185. What do the authors mean by “accidental discoveries”?
- L186. Please specify which type of flexibility the authors refer to.
- L184-L186. Please provide appropriate references.
- L195-L205. I found this paragraph repetitive.
- L215-L216. Please provide appropriate references.
- L232-L236. Consider to rewrite this paragraph.
- L238-L239. Please provide appropriate references.
- L259-L260. Why is this sentence quoted?
- L270-L271. What do the authors mean by “precipitation of moisture”? Do they mean rainfall? Moisture cannot precipitate.
- L275. What do the authors mean by “are to a larger or lesser extent”? Please be specific.
- L276. Yes, it has been widely studied. Consider to review the work by I. Rodríguez-Iturbe.
- L280. Figure 6 does not indicate that.
- L297. I don't agree that it's always mainly driven by topography. Please provide references.
- L297. What do the authors mean by “runoff threshold has a spatial distribution function”? That is confusing. Runoff can vary in space and that variation can be represented by a function.
- L298-L299. This sentence is not clear. Please indicate first what.
- L301-L302. Is called by who? Please provide the references.
- L304. Is P intensity, depth, frequency? Precipitation can be quantified with different variables.
- L305-L306. In Gao et al, 2017 beta is defined as a parameter of the storage capacity curve function. It determines the shape of this curve.
- L313-L314. Please define “matrix infiltration capacity” and “preferential infiltration capacity”.
- L335. Please differentiate between superficial and depth runoff..
- L344. Are the authors referring to flow in streams?
- L351-L355. Please provide appropriate references.
- L376-L377. Please provide appropriate references.
- L387. Why “inversely”?
- L400-L402. Please clarify this sentence.
- L407. What do the authors mean by “climate change”? That is very general.

#### **Section 4**

- L425. The upper boundary is the atmosphere not climate.
- L427-L428. That is not such general. Please provide the references.
- L433-L435. Please provide the link between this statement and the manuscript.
- L435. What do the authors mean by “By comparing Sumax with aboveground tree cover”? This sentence is not clear.
- L436. Please specify which type of transitions the authors are referring to.

- L438-L439. Please provide appropriate references.
- L456-L459. Please clarify which carbon storage alternatives are the authors referring to.
- L471. Please provide appropriate references.
- L479-L489. Please explain the link between this paragraph and the manuscript.
- L505. Which land surface fluxes do the authors mean?
- L509. Do the authors refer to transpiration instead of evaporation?
- L509-L510. Not necessarily. If the transpiration rate is high, that water would also be transpired.
- L520-L522. Please provide appropriate references.
- L635. Please indicate easier in what sense.

### **Section 5**

- L557-L558. Please provide appropriate references.
- L602. What do the authors mean by “large diversity in hydrological fluxes”? Please be more specific.
- L628-L629. Which one is the “most complex reductionist approach in runoff modelling”?

### **Figures**

- Fig. 1. This figure is only briefly mentioned in the body text. Besides, the legend does not completely describe the figure.
- Fig. 2. This figure is only briefly mentioned in the text.
- Fig. 3. This figure is only briefly mentioned in the text. It has three panels and they are not mentioned in the text.
- Fig. 4. This figure shows a lot of information that is not even mentioned in the text.
- Fig. 5. This figure has 6 panels and the legend does not describe them. And, as it occurs with the other figures, this shows a lot of information that is not even mentioned in the text.
- Fig. 6. The legend does not correspond to the figure. The figure shows all the components of the hydrological cycle and its parts are not mentioned in the text. Besides, why there is a root zone under the snow?