

## ***Interactive comment on “A Water-Energy-Food Nexus Approach for Conducting Trade-off Analysis: Morocco’s Phosphate Industry in the Khouribga Region” by Sang-Hyun Lee et al.***

### **Anonymous Referee #1**

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This paper brings a timely and relevant topic about going beyond classical mono criteria approaches to a more complete comprehensive approach that analyses not just one aspect of the system but rather involves more indicators which help to conduct trade-offs analysis on shared primary resources between competing sectors. The authors applied a Water-Energy-Food Nexus-tool to assess the interaction between the agricultural sector and the phosphate industry on regional water, energy, and food systems in Khouribga, a representative phosphate mining area of Morocco. The authors suggested that their developed tool can assist in making a more sustainable resource management plan. Their results recommended the dynamic monthly management of phosphate production in terms of water and energy savings, especially during the

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water-scarce season. However, I have some methodological and structural concerns that need to be addressed before publication.

General comments:

1. The authors developed and used WEF-P tool which takes into consideration a number of footprints indicators such as water and energy. The authors decided to exclude the economic perspective from their analysis without giving a concrete reason. Since the authors claimed that their tool can “becomes a management-decision aid for effectively ensuring more sustainable management of limited resources and increased reliability of water resources for both agricultural and industrial use”. The economic aspect of phosphate production needs to be addressed and included in this paper. Otherwise, the authors need to give a very good reason if they decide to don’t do so (not the way they mention it now briefly in their study limitation) and maybe avoid overestimating the effectiveness of their tool as a decision aid.
2. The water footprint (WF) is defined loosely. The authors referred to water footprint calculation while in the end, they seem to use the evapotranspiration as irrigation water requirement which needs clarification since the water required for irrigation is not the same as evapotranspiration and not the same as water footprint of crop production.
3. The authors developed target production scenarios that they mention in their result and discussion section. How are the scenarios developed and why? The authors could include their scenarios in the materials and method section: “The production of raw phosphate of the year 2015 forms the “business as usual scenario” (BAU). Three additional scenarios will be considered based on a combination of the production process and the mode of transportation. Scenarios 1 is when all raw phosphate is transported by pipelines . . .” something like this.
4. When calculating the WF, what was the considered period? Is it the calendar year or the growing period of crops? This needs clarification and the study boundaries should be well defined. If the authors considered the calendar year, they also need to assume

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that there was nothing planted from the previous year. Otherwise, in some months of the year, there will be an overlap between current crops and last year crops that should be considered. For wheat, for example, it is planted in November so it will be harvested in the next year. Is the water used in the next year will not be accounted for or is wheat considered a rainfed crop?

5. The authors need to improve the structure of their paper. The data, methodology, units and scenarios need to be defined before the results and discussion section. It is sometimes hard to differentiate the study assumptions and the defined scenarios from the results and discussion.

Specific comments:

1. The introduction and the article, in general, have a relatively limited literature review. This lack of references is, in my opinion, caused by two facts. First, the authors developed and used a tool while they didn't introduce anything concerning the tool creation, why it is needed? What is the difference between the WEF Nexus Tool 2.0 and the one created here and other frameworks and Nexus tools? What are the limitations of other tools in assessing what the current tool could assess? Second, the authors should make more references to other studies that used the WEF concept and compare their framework and findings. This will also be useful for the authors to place their findings in the context of other studies that applied the WEF Nexus in the paper's discussion.

2. Lines 47 - 62: WEF concept has also been recognized as a strong support to achieve the Sustainable Development Goals (SDGs) see Terrapon-Pfaff et al. (2018) for instance: Terrapon-Pfaff, J., Ortiz, W., Dienst, C., and Gröne, M.-C.: Energising the WEF nexus to enhance sustainable development at local level, *Journal of environmental management*, 223, 409-416, <https://doi.org/10.1016/j.jenvman.2018.06.037>, 2018.

3. Line 66: You better refer to the world bank (2019) and not to the link in the text and in reference list refer to "World development indicators".

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4. Line 68: Same as the previous comment, refer to FAO (2015) in the text and the following in the reference list: FAO: FAOSTAT Online Database, Statistics Division, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, 2015.

5. Line 70: also, here refer to world bank 2019 and maybe use suffixes a and b following the publication year to make the difference between the references to world bank data you made.

6. Line 71: maybe add a reference here?

7. There are many sentences in the introduction that seem to be quotes from literature that are not cited. Check lines 74 - 84 for example. For instance, you should give a reference to the following: "especially in a country that imports nearly 90% of the energy it consumes".

8. Lines 97 - 98: "New water (grey, produced, brackish, and waste) is a resource with the potential to significantly contribute to bridging water and food gaps (Mohtar et al., 2015)" you make a difference between grey and wastewater and between produced and brackish water. What is the difference between grey and wastewater? What is the source of produced water then, are you referring to desalination? What is the share of this new water resources use in total water used in agriculture? How safe is the use of treated wastewater in agriculture in Morocco to consider its contribution as significant?

9. Lines 113 - 135: In your site description, it is not clear what is your system boundaries. Are you considering the whole region Khouribga? Or just the mining areas and it's surrounding? How is the surrounding defined for agriculture activity for instance?

10. Line 117: "fields indicate 1.68 million tons of raw phosphate were excavated". What represents this number for the total country's production of raw phosphate?

11. Line 128: "Plan Maroc Vert". It is maybe better to refer to the English name: the "Green Morocco" plan. Maybe add a reference to the Green plan or the national water

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plan that refers to moving from groundwater to surface water use.

12. Lines 160 - 161 "footprints are calculated using a regression function, or average value based on survey data, and technical experts in each process can modify this relation function as needed". This is not very clear. What regression function you used to calculate water and energy footprint? Please elaborate in this and explain what data comes from surveys and which technical experts you mean?

13. Line 206: You better refer to FAO report 46.

14. What is the methodology you used for accounting the water footprint of crop production?

15. Lines 231 - 232: Is it possible to include the unit of phosphate production somewhere in the materials and methods section?

16. The following sentences give the same information: "In 2015, 1.68 million tons of raw phosphate was mined and transported from the mining to the manufacturing area, monthly" and "In the mining area, 20.1 million tons of raw phosphate were produced in the 2015". The only difference is monthly or yearly production. Can you combine the information about target production and the BAU scenario to avoid repetitions?

17. Lines 266 – 267: Are the considered crops the only produced crops in that area? Why setting the target production to exactly 0.1%? Is that the potential production of the considered area? Is that the target production for each crop?

18. Food production is not only crop production but also livestock production. Since you are not including this aspect of food production in your study you need to maybe spend one sentence in the limitation of the paper or somewhere to make this clear.

19. Line 274: The waste-water treatment plant capacity seems to be taken from somewhere, maybe add a reference?

20. In figure 3, the amount of rainfall in March seems to exceed rainfall in November

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and December but irrigation is still needed in March. You better include the harvested date next to the planting date in Table 1 to give an idea of how many crops have their growing period in March.

21. The first sentences in Line 303 and line 316 seem to be the same.

22. Line 327 – 331: Dynamic phosphate production contributes to electricity savings in only 6 months of the year (from May till October). However, in the rest of the year, the consumption of electricity in the dynamic phosphate production was higher than the static production.

Minor comments: 1. Line 64 and Line 74: You miss a comma (Taleb, 2006) and (OCP, 2013). These are just examples; you need to check all your references and format them according to HESS guidelines.

2. Line 91, energy is repeated twice.

3. Table 1. You better remove the reference from the table's title and insert it in Line 225: "FAO provides crop coefficients for each stage". Alternatively, you can add it as a note under the table.

4. In Table 1's title "Information" doesn't need to be capitalized.

5. In Table 1: Plant data: do you mean Planting date?

6. Line 233: remove the additional backslash → tons months-1

7. Figure 4: Include more description in the figure's title and reduce the text in the figure's legend. Try to include the legend in the figure as it seems now to be outside.

8. Same for figure 5: Groundwater use is already in the figure's title. The legend could be just: Dynamic production and Static production.

9. Same for figure 6.

10. There are some small typographical errors throughout the paper and these should

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be corrected.

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