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Interactive comment on "The Nexus Solutions Tool (NEST): An open platform for optimizing multi-scale energy-water-land system transformations" *by* Adriano Vinca et al.

Chrysi Laspidou (Referee)

laspidou@uth.gr

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The article includes an impressive line-up of authors from prestigious institutes around the world and proposes a model that is promising and will be appreciated by the scientific community. It presents a Nexus analysis, which is valuable and covers the synergies and trade-offs that are realized when a series of SDGs specifically considered are achieved. The case study of the Indus River Basin in South Asia is developed to showcase model results. This is a transboundary case study, including India and Pakistan, so it is really valuable to see how each country is affected differently.

Some of the issues with the paper that the authors should address are the following:

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- It is not clear what scale the platform is developed for. My impression is that it is developed on a global scale, but only the Indus River Basin is presented in this article with the different SDG scenarios, so the scale is not very clear from the manuscript. This is important to mention in order to let the reader know what the potential of this platform is. - Data Sources: It is not clear where all the data presented in the article come from and how reliable it is. For example, in Figure 3 we see that for the water system the modelling entities are surface water, ground water and saline water, with each one of these streams being split to urban use, rural use, irrigation, etc. As a result, fresh water is allocated to a total of 12 “diversions”, with many of these diversions having a different value for surface water and groundwater. Furthermore, urban and rural water use is split to piped and unpiped distribution and all kinds of waste streams are modelled separately. This is an impressively fine granularity of data, but how possible is it to define all this with some sort of reasonable accuracy for a country, or even a region? It is important that the authors show that this type of data is available and that it is reasonable to consider it in such a detail. Obviously, it is a plus to present the water system in great detail, but when the data cannot support that detail, then it becomes an important source of error. The fact that each one of the “diversions” has its corresponding energy associated with itâĂŤinformation that feeds the energy systemâĂŤindicates that any error introduced in the water system with this classification will also be propagated to the energy system. If the authors use gross approximations for allocating demands to the different modules, then it is not clear how beneficial such detail is at the end. Experience shows that there is a lot of inaccuracy and error in this data and the modeller is better off relying on national or regional statistics, rather than on global databases. Whatever the case, the authors should definitely address this critical issue. Needless to say that the same issue of presenting an extreme level of detail without supporting it with the corresponding data applies for all systems, not only for the water system. The way it is presented right now, there is a serious lack of detailed explanation, which reduces the scientific reproducibility of the modelling science in the article. - SDG2 and Figure 8 (Land use by crop): Even though SDG2 refers

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to food security, the authors do not clearly show how food security is affected. They show cotton and fodder that are not intended for human consumption, for example. Also, the fact that they show land used for crops and not yields makes a comparison difficult. For example, for the multiple SDG scenario, many of the crops are substituted by non-irrigated, which might have lower yields, when compared to irrigated. How does that affect food security? I understand that the authors explore SDG 2.4, which only refers to irrigation technologies, but it is a bit misleading when addressing SDG 2, to present and compare land used for crops and make no reference to food security and how food production is affected. - Figure 7(b): When comparing baseline and multiple SDG scenarios, we see that there is a great increase in Energy for Water and a great decrease in water for irrigation. But, how are Green House Gas emissions affected with such Energy increase and how is food security affected with such a reduction in irrigated land? This is an important question that comes to mind and is not addressed in the text. - Figure 7(a) / Nuclear Energy: I see that the authors drastically increase the use of nuclear energy in the suggested multiple SDG scenario. I assume that this was done due to the high efficiency of nuclear plants, which made possible to achieve the SDGs considered. However, it is not clear if such an increase in nuclear is desirable and/or even feasible for these countries. The amount of nuclear power used in the electricity mix of individual countries is a complex issue and it depends on many factors. It is not clear whether the authors have considered these factors for the case study presented, or whether the increase in nuclear power is merely a “modelling decision”. - Discussion: What is missing from the manuscript is some discussion on the Nexus, in association with the results. For example, looking at Figure 7, when comparing baseline and multiple_SDG scenarios, we see that as one arrow gets thinner, another one gets thicker, which in a sense shows the effects of a Nexus analysis. In other words, we see the interdependence and “compromise” in resource use (we can’t reduce everything at the same time, or as we reduce one sector, another one is affected). The choice of what is reduced and what is increased and the effects of these interlinkages is at the heart of a Nexus analysis and I feel that such a discussion after the presenta-

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tion of results is missing. Also, the coherence of the SDGs themselves is relevant and should be discussed. How are things different when one tries to achieve only one goal vs. when multiple goals are considered. This is shown quite clearly in Figure 8, but the discussion on the coherence and/or conflicts of the SDGs themselves seems to be missing. - Uncertainty / Sensitivity: There is no mention of an uncertainty/sensitivity analysis of the results in the article. Such an assessment is necessary, even if it is limited, since in reality this uncertainty is multifaceted, involving human behaviour and is not so easily quantified.

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