Comments on hess-2024-112

1.general comments

This paper investigates a method for mapping the potential continental-scale distribution of GDEs using a global groundwater model, which aligns with the scope of HESS. The framework and steps for mapping GDEs are clearly delineated. Although there are some discrepancies between the results and the actual atlas, the findings are still acceptable for large-scale research, and the results are adequate to support the interpretations and conclusions. Unfortunately, the data and parameters necessary for coupling large-scale hydrological models with groundwater models—such as precipitation, evaporation, groundwater extraction, infiltration zoning, aquifer characteristics, and groundwater levels—are not yet clearly presented. Additionally, the impact of climate change and human activities on groundwater recharge has not been thoroughly analyzed. There has been insufficient discussion comparing the application of modeling methods with other remote sensing techniques. This indicates that the paper requires further revision and enhancement.

2.specific comments

（1）Abstract

The manuscript states that at the end of the Abstract section ″The proposed framework and methodology provide a basis for analyzing how global impacts of climate change and water use may affect GDEs extent and health″, However, there appears to be no data or analysis of outcomes regarding climate change and water use to support this claim.

(2) Introduction

Since remote sensing is used as one of the effective methods in both regional and continental scale for identifying the potential GDEs distribution, why does the author abandon the approach and instead directly employ the surface water-groundwater model method for simulation and mapping of GDEs? Why not combine remote sensing method with surface-groundwater modeling method together?

(3) Data and methodology

This section outlines three steps of the GDEs mapping framework with illustrations and figures. However, the third step in Fig.1 presents the content of static GDEs mapping and analysis, which appears to lack the transient GDEs mapping analysis.

Section 2.1 Defining GDE classes (step 1)： The author defines that the saturated area fraction greater than 50% and a shallow groundwater table (less than 5m) classified as a wetland GDEs. What is the scientific basis for that?

Section 2.2 Model set-up, sensitivity analysis and output evaluation (step 2)：

This section does not explore how the conceptual models of hydrology and groundwater are constructed, particularly how the boundary conditions of continental-scale groundwater models are established, how the permeability coefficients of phreatic aquifers, confined aquifers and riverbeds are acquired, and how the boundaries and hydraulic connections between the adjacent basins or hydrogeological units are determined. Is it necessary to mesh-refinement so that the conductance data from riverbeds be utilized in groundwater models? In determining net recharge, how can data be obtained on evaporation for aquatic area, wetland and terrestrial area, as well as groundwater infiltration due to precipitation? For the Pcr-globwb-2 model to simulate the saturated area fraction, which soil parameters or parameters from the unsaturated zone and saturated zone need to be input?

Section 2.3 GDE mapping (step 3):

When selecting transient GDE mapping, why are the two time periods 1979-1999 and 2000-2020 chosen? Are they related to climate change (such as changes in precipitation) and shifts in human activity (such as groundwater extraction)?

(4) Results

Groundwater depth is a crucial parameter for determining the GDEs, particularly the terrestrial GDEs, for example depth of 5m just mentioned in the paper, as it most directly reflects the distribution of GDEs. Why not select the typical years from the period of 1979-1999 and 2000-2020 to create a contour map of groundwater depth and compare it with the atlas that has already been produced?

This paper examines the contribution of groundwater to the stream in the Murray-Darling basin. However, how can you explain the decline in the dependency ratio when both groundwater levels and stream flow are decreasing? Were the monitoring sites for groundwater levels and stream flow selected from the upper, middle, or lower reaches of the basin? We are unsure whether the simulation accuracy at the watershed-scale will be higher than that at the continental-scale. Why not to map the distribution of GDEs at the basin-scale for typical years and compare the results with the actual atlas and then get a hit rate?

(5) Discussions and conclusions

The method discussed in this paper still exhibits a notable gap in evaluation accuracy when compared to the actual GDEs distribution derived from the Australian atlas. Can it be utilized for assessments at other regional, continental, and even global scales? What are the advantages and disadvantages of this method in relation to other scholars' combined remote sensing hydrogeological survey techniques? Has it been compared and analyzed against the relevant results of the following article? ——Rohde, M.M., Albano, C.M., Huggins, X. *et al.* Groundwater-dependent ecosystem map exposes global dryland protection needs. *Nature* **632**, 101–107 (2024). https://doi.org/10.1038/s41586-024-07702-8

3. technical corrections

Line 19: "using a hit rate, false alarm, and critical success index," Perhaps the term "missing rate" was lost. It would be changed to "using a critical success index derived from hit rate, false alarm, and missing rate"

Line 99, Fig. 1: The abstract outlines a step for evaluation of transient mapping; however, Figure 1 does not provide an analysis and its arrow indication is unclear. The name of fig. 1 is "Groundwater dependent ecosystems (GDE) modelling framework or mapping framework?

Line 110-111: Please confirm it is that the maximum rooting depth is greater than the depth to groundwater table.

Line 229: groundwater level variation ∽80% with a relative variance < 0. 6). _ missing a bracket.

Figure 3: Lack of scale bar

Line 261: false alarm ratio, or false alarm rate?

Line 262-263: and green represents hit rate.

Line 285 Figure 5: The figure is unclear and lacks a scale bar.

Line 294: depends on groundwater level and streamflow.