

1 # CC1

2

3 We thank you for your valuable comments, which have greatly strengthened the manuscript.

4 **Combined with the comments from reviewers #RC1 and #RC2, the revised version is**

5 **presented as follows: red for your comments, black for our responses, and blue for the revised**

6 **manuscript text. This is our second reply to your first valuable comments.**

7

8 **General Comments:**

9 This manuscript presents a timely and important study that challenges the conventional view of

10 gullies as purely erosional, degraded features by positioning them as significant zones for

11 groundwater recharge in the semi-arid Loess Plateau. The research employs an integrated

12 multidisciplinary approach, combining stable isotope analysis, chloride concentration

13 measurements, water-level fluctuation analysis, and hydro-statistical modelling to trace moisture

14 flow paths among surface water, pore water, fissure water, and spring water at a high resolution.

15 Based on this evidence, the authors redefine the hydrological role of gullies in arid ecosystems,

16 directly challenging the traditional view of gullies as symbols of land degradation. The findings

17 reveal that reframing gullies are not merely degraded geomorphic units but rather critical

18 groundwater recharge zones and subsurface connectivity hubs. Precipitation primarily replenishes

19 shallow pore water, while deep fissure water is supplemented by slow, top-down percolation. This

20 understanding overturns the long-standing negative perception of gullies on the Loess Plateau,

21 highlighting their capacity to buffer seasonal hydrological variability and enhance ecosystem

22 resilience. Overall, this study addresses a key knowledge gap regarding groundwater dynamics in

23 gully systems and holds significant practical implications for sustainable water resource

24 management on the Loess Plateau. The manuscript is generally well-written and structured.

25 However, some moderate revisions are needed.

26 **Response:** Thank you for taking the time to review our manuscript and for providing valuable and

27 constructive comments. Your feedback has greatly helped us improve the manuscript. We fully agree

28 with your comments and have made substantial revisions to enhance its readability and academic

29 rigor. Below are the specific changes we made, along with our point-by-point responses to your

30 comments.

31

32 **Major Concerns:**

33 1. The manuscript sets up a contrast with “piston flow” and “preferential flow” models from
34 tableland studies but does not clearly define what process is dominant in the gullies. The proposed
35 “gully-dominated preferential recharge mechanism” (Line 779) is not well-defined. Is the
36 “preferential” aspect the topographic focusing of runoff into the gully, or are there actual preferential
37 flow paths (macropores, cracks) within the gully soils?

38 **Response:** Regarding the term “gully-dominated preferential recharge mechanism”, we have
39 clarified and revised the description as follows: In the study area, the gully system is characterized
40 by homogeneous, fine-grained loess, where water movement primarily follows piston flow (Yu et
41 al., 2025). In this context, “preferential” refers to the topographically driven process in which gullies
42 act as critical convergence zones, efficiently concentrating hillslope runoff and leading to spatially
43 focused and enhanced recharge flux, rather than indicating the presence of preferential flow paths
44 such as macropores or fractures. The specific revision is as follows:

45 “Crucially, the model offers insight into the multifunctionality of ecological engineering,
46 particularly check dams and ponds, in enhancing groundwater recharge, and supporting ecosystem
47 restoration across the Loess Plateau. **This study proposes a cascade-type recharge framework**
48 **for engineered gully systems, highlighting the role of engineered gullies as convergence**
49 **pathways that locally focus infiltration and groundwater recharge. Rather than invoking**
50 **preferential flow within the soil matrix, this framework emphasizes topographic convergence,**
51 **stratigraphic thinning, and engineered ponding as the dominant mechanisms that promote**
52 **spatially concentrated recharge within gully zones. While this process is demonstrated using**
53 **site-specific tracer and water-table observations, its broader relevance at the catchment scale**
54 **remains conceptual and warrants further investigation. Furthermore, water movement within**
55 **the silted loess layer of the gully system remains dominated by a piston flow pattern (Yu et al.,**
56 **2025).** By identifying the pivotal role of gully systems in stormwater detention, delayed infiltration,
57 and depth-partitioned recharge, this study establishes a mechanistically grounded conceptual basis
58 improving water resource allocation, infrastructure planning, and groundwater sustainability in arid
59 and semi-arid regions.”

60

61 2. In my opinion, the manuscript could benefit from clearer articulation of the broader implications
62 of the key findings. For example, how can this insight change land management practices or
63 ecological restoration strategies in other dryland regions globally?

64 **Response:** To enhance the broader implications of the study, we have expanded the discussion to
65 highlight the global relevance of our findings, particularly with regard to land management practices
66 and ecological restoration strategies in other arid and semi-arid regions. The specific additions are
67 as follows:

68 “However, with the reconstruction of gully systems and ecological restoration, attention must also
69 be given to the potential risks of pollutant migration (Yu et al., 2020). The hydrological functions
70 of gullies may enhance the movement of pollutants into groundwater, especially in areas with
71 intensive human activities, where pollutants can enter engineered gullies through surface runoff and
72 subsequently infiltrate the groundwater system. **During ecological restoration, excessive human**
73 **intervention or soil improvement measures may lead to the accumulation and dispersion of**
74 **pollutants, which may compromise groundwater security (Liu et al., 2017).** Therefore, the
75 **protection and rational reconstruction of gully systems should not only focus on their**
76 **hydrological functions but also consider potential environmental risks, particularly the**
77 **pathways of pollutant migration.** These findings therefore underscore the need to evaluate
78 **gully-based restoration strategies within an integrated water-quality and groundwater-**
79 **protection framework (Obuobie et al., 2012; Zhao et al., 2019; Zhao et al., 2021; Xue et al.,**
80 **2025).**

81 **The study confirms that hydrologically arrested gully systems can function as critical**
82 **“recharge windows” for groundwater in arid areas. This underscores the importance of**
83 **strategically identifying and managing gully networks in watershed management, while**
84 **avoiding excessive filling or hardening to preserve their hydrological functions. In ecological**
85 **restoration projects, directing surface runoff toward engineered gullies under controlled**
86 **conditions can efficiently convert limited precipitation into groundwater storage, thereby**
87 **enhancing regional water retention capacity.** Beyond advancing theoretical understanding of

88 regional hydrological processes, this conceptual model provides a process-based foundation for
89 developing spatially targeted models of groundwater recharge in managed dryland landscapes.”

90 **Reference**

91 Obuobie, E., Diekkrueger, B., Agyekum, W., Agodzo, S. Groundwater level monitoring and
92 recharge estimation in the White Volta River basin of Ghana. *Journal of African Earth Sciences*. 71-
93 72: 80-86, 2012. DOI: 10.1016/j.jafrearsci.2012.06.005.

94 Xue, S.B., Li, P., Cui, Z.W., Li, Z.B. The influence of different check dam configurations on the
95 downstream river topography and water-sediment relationship. *Journal of Hydrology*. 656: 133046,
96 2025. DOI: 10.1016/j.jhydrol.2025.133046.

97 Zhao, Y., Wang, L. Determination of groundwater recharge processes and evaluation of the “two
98 water worlds” hypothesis at a check dam on the Loess Plateau. *Journal of Hydrology*. 595: 125989,
99 2021. DOI: 10.1016/j.jhydrol.2021.125989.

100 Zhao, Y.L., Wang, Y.Q., Sun, H., Lin, H., Jin, Z., He, M.N., Yu, Y. L., Zhou, W. J., An, Z. S. Intensive
101 land restoration profoundly alters the spatial and seasonal patterns of deep soil water storage at
102 watershed scales. *Agriculture, Ecosystems & Environment*. 280: 129-141, 2019. DOI:
103 10.1016/j.agee.2019.04.028.

104

105 **Specific Comments:**

106 1. It is recommended to simplify long sentences to improve readability. For example, lines 53–56:
107 “In these ‘fragile’ and diverse landscapes, understanding the processes that govern when, where,
108 and how groundwater is replenished—including the countervailing influences of vegetation
109 dynamics, geomorphology, and engineered features—is essential for sustaining ecosystems,
110 securing water resources, and informing land restoration and catchment management.” This
111 sentence is structurally complex and could be simplified by breaking it into shorter clauses or
112 highlighting the core information more clearly.

113 **Response:** We have simplified the sentence to enhance readability. The revised version is as follows:
114 “In these fragile landscapes, understanding groundwater replenishment processes is crucial for
115 sustaining ecosystems, securing water, and guiding restoration and management (Gleeson et al.,
116 2016; Jasechko and Perrone, 2021; Scanlon et al., 2006).”

117

118 2. The text categorises groundwater into “pore water, spring water, fissure water”, and further
119 suggested that the criteria for classification be clarified, such as medium type, storage space, and
120 relationship with aquifer structure, to help readers understand the logical framework. The definition

121 of "piston flow" (Line 145-146) is helpful but could be more concise. Consider: "Piston flow
122 describes the displacement of pre-existing water by newly infiltrating water, moving frontally
123 through the pore spaces."

124 **Response:** We have further elaborated on groundwater medium types, storage spaces, and
125 relationship with aquifer structure to improve the clarity of the logical framework for readers. The
126 specific revisions are as follows:

127 "Groundwater in the catchment can be broadly categorized into three types: pore water, spring water,
128 and fissure water. Pore water is stored in permeable sandstone and conglomerate aquifers beneath
129 loess and above mudstone or red clay. These aquifers are approximately 2–3 m thick, exhibit a sheet-
130 like distribution, and have low water yield. Conceptually, "pore water" here refers to groundwater
131 in a saturated aquifer, not to soil moisture. Fissure water occurs in fractured bedrock aquifers, which
132 are spatially discontinuous due to irregular fracture development. The main water-bearing zones
133 include cavities and jointed fissure networks, with an average aquifer thickness of about 6 m and
134 moderate water yield. Hydraulic conductivity in these sandstone and conglomerate aquifers ranges
135 from 0 to 0.47 m/d (Cai et al., 2019). Spring water emerges primarily at gully bases, especially in
136 upper catchments, and originates from both pore and fissure sources, possibly supplemented by
137 surface or pond water. Springs fed by pore water typically have low discharge rates (0–0.1 L/s) and
138 low water yield, while those fed by fissure water exhibit moderate discharge rates (0.5–1.0 L/s) and
139 moderate water yield.

140 Regarding the definition of "piston flow", this section has been removed in response to
141 Reviewer #RC2's comment.

142
143 3. The manuscript lists permeability for Neogene coarse sandstone and conglomerate as 7.5–36.19
144 m/d (lines 213–214). These magnitudes are unusually high for such lithologies; I suspect a units or
145 conversion mistake and recommend the authors re-examine the original data and report corrected
146 values if necessary.

147 **Response:** In the original manuscript, the permeability unit at Line 214 was listed as 'Lu' but was
148 incorrectly noted as 'm/d' (7.5–36.19 Lu≈0.07–0.31 m/d). In this revision, we have verified the
149 permeability units and made the necessary conversions. The revised version is as follows:

150 "The significant reduction in loess thickness, combined with the relatively high permeability of

151 Neogene coarse sandstone and conglomerate (0.07–0.31 m/d), creates favorable conditions for
152 infiltration and focused recharge.”

153

154 4. The text indicates that a low ITTP represents a long residence time, but the high ITTP of ponds
155 (1.5 ± 0.7) is interpreted as "rapid turnover+evaporation dominance," seemingly overlooking the
156 effect of evaporation on increasing variance. Could this be due to the small sample size for
157 ponds/springs affecting the reliability of the analysis? Additionally, what is the reason for the small
158 sample size for ponds/springs?

159 **Response:** In our analysis, the high ITTP values observed in the pond were interpreted as resulting
160 from the combined effects of "rapid turnover and evaporation dominance". As an open, shallow
161 water body, the pond experiences strong evaporation, which preferentially removes lighter isotopes,
162 enriching the remaining water with heavier isotopes, thereby increasing the variance in isotopic
163 composition. We acknowledge that evaporation is one of the factors contributing to the increased
164 variance, which may introduce bias into the estimation of apparent residence times. This has been
165 addressed in the original manuscript, as follows:

166 “The inverse transit time proxies (ITTPs) broadly support the dual-isotope interpretations of water
167 source dynamics. **Pond water exhibited the highest ITTP values (1.5 ± 0.7), indicating rapid**
168 **turnover and limited subsurface storage. These elevated values likely reflect inputs from direct**
169 **rainfall and overland flow, as well as evaporative enrichment, which increases isotopic**
170 **variability and can artificially shorten the apparent residence time.** In contrast, pore water
171 (0.7 ± 0.3) and fissure water (0.6 ± 0.5) showed lower ITTPs, consistent with longer residence times,
172 greater subsurface mixing, and attenuation of seasonal isotopic signals due to delayed recharge.
173 Spring water had the lowest ITTPs (0.3 ± 0.2), reflecting slow subsurface transport and integration
174 of older water sources (Fig. 8).”

175 Additionally, your comment regarding the potential impact of sample size on the robustness of
176 statistical inferences is valid. It is important to note that the pond water (n=7) and spring water (n=9)
177 samples reported in this study represent all available valid samples within the research area. This
178 sample size significantly exceeds the minimum requirements for replicate observations in
179 conventional hydrological isotope studies (typically ≥ 3 replicates). The collection of 7 pond water
180 and 9 spring water samples in a 54 km² arid-to-semi-arid study area reflects good spatial coverage

181 and hydrological representativeness, indicating that the sampling effort is both sufficient and
182 meaningful at the study scale. The relatively large standard deviation of the pond water samples,
183 covering locations with varying evaporation intensities from upstream to downstream, precisely
184 reflects the natural variability of the actual hydrological processes. Therefore, sample size alone is
185 unlikely to be the primary factor affecting the reliability of the analysis.

186

187 **5. The high recharge rate of gully groundwater, accounting for 43% of precipitation—significantly**
188 **higher than that in hill areas (<20%)—is a core conclusion of this paper and key evidence supporting**
189 **the claim that “gullies are critical groundwater recharge zones and subsurface connectivity hubs.”**
190 **While this conclusion is important, its robustness and uncertainties require further discussion, such**
191 **as the assumptions underlying the recharge rate estimation method, spatial representativeness, and**
192 **the impact of extreme events.**

193 **Response:** The estimation method for the recharge rate has been thoroughly discussed in the
194 manuscript, including the underlying assumptions. To further strengthen the robustness of our
195 conclusions, we have supplemented the discussion with considerations of spatial representativeness
196 and the impact of extreme events, as per your comment. The specific additions are as follows:

197 **“The total recharge from 2023 to 2024 was estimated at 241.4 ± 6.0 mm and 238 ± 6.0 mm using**
198 **the MRC and RISE methods, respectively. Under constant specific yield conditions, the MRC**
199 **method typically estimates higher groundwater recharge and recharge days than RISE, as it accounts**
200 **for groundwater table decline due to lateral outflow and other discharge processes in the absence of**
201 **recharge (Heppner and Nimmo, 2005). Our findings support this pattern. Furthermore, the key**
202 **parameter for estimating groundwater recharge using the water table fluctuation method is**
203 **specific yield (Sy), which depends on soil properties and water table depth (Liang et al., 2015).**

204 **Shallow soil measurements (0–50 cm) using the test pit method (total porosity minus field**
205 **capacity) yielded $Sy \approx 0.03$, consistent with high capillary retention in near-surface loess (Wang**
206 **et al., 2024). However, for water tables deeper than 2 m (as in this study, typically 4–10 m), the**
207 **test pit method provides a reliable estimate of aquifer-scale drainable porosity (Nachabe, 2002;**
208 **Shah and Ross, 2009; Liang et al., 2015). Accordingly, we adopted $Sy = 0.032$, aligned with**
209 **values of ~ 0.03 reported for similar loess-derived unconfined aquifers on the Loess Plateau**
210 **(Wang et al., 2023). Sensitivity analysis indicates that recharge estimates vary by**

211 approximately $\pm 25\%$ across the plausible S_y range (0.032 ± 0.008), reflecting uncertainty in
212 effective drainable porosity within shallow gully aquifers.”

213 “Research on groundwater recharge in the Loess Plateau has mainly focused on deep-profile
214 unsaturated zones in the tableland and hilly areas, with tracer methods estimating recharge between
215 9 to 100 mm (Huang et al., 2011; Li et al., 2017; Xiang et al., 2019; Lu, 2020; Wang et al., 2024).
216 In contrast, our study in the gully region indicates recharge of up to 240 mm, much higher than
217 previous estimates on deep-profile unsaturated zones. This difference reflects several factors: 1)
218 Unsaturated zone thickness: In the gully region, the unsaturated zone is generally less than 10 m
219 thick, much shallower than in tableland and hilly areas (mean thickness of 92.2 m), making
220 infiltration easier and promoting effective recharge. 2) Gully topography and hydrology,
221 characterized by well-developed channels, concentrated runoff, and widespread ponds and check
222 dams, promote focused infiltration (Liu et al., 2017; Li et al., 2021; Xue et al., 2025). 3) Research
223 methods: Tracer methods reflect long-term recharge rates and are better suited for thicker
224 unsaturated zones (Huang et al., 2011; Lu, 2020; Li et al., 2017). In contrast, the water table
225 fluctuation method directly captures short-term recharge dynamics and works better in thinner
226 unsaturated zones. Moreover, this method also better captures surface water-groundwater
227 interactions and focused recharge effects (Gumula-Kawęcka et al., 2022). These findings underscore
228 the importance of studying recharge in gully regions, filling a research gap in the Loess Plateau's
229 geomorphology and providing new ecohydrological insights. However, the robustness of our
230 findings requires further exploration. On one hand, due to the limited spatial distribution of sampling
231 points, the current results primarily reflect the hydrological characteristics of engineered gullies,
232 and their representativeness at the regional scale requires validation through future expansion of the
233 monitoring network. On the other hand, the study period did not encompass extreme precipitation
234 or drought events, which may significantly alter surface flow convergence conditions and vadose
235 zone water transport mechanisms, thereby substantially impacting recharge processes. Future work
236 should strengthen dynamic monitoring and simulation analysis under extreme hydrological
237 scenarios.”

238
239 6. Fig. 9 shows that significant rises in groundwater levels and the main recharge period occur during
240 the drier autumn and winter seasons (October to April), while recharge during the summer monsoon

241 rainfall peak is minimal. The authors explain this as effective infiltration during the “cool, low-
242 evaporation period” (Lines 601-604). Are there other potential reasons? For example, freeze-thaw
243 processes, soil water reservoir effects, antecedent moisture conditions, or the competition between
244 rainfall intensity and infiltration capacity?

245 **Response:** We fully agree with your comment. In addition to effective infiltration during the “cool,
246 low-evaporation period”, factors such as freeze-thaw processes, soil water storage effects,
247 antecedent moisture conditions, and the competition between rainfall intensity and infiltration
248 should also be considered as influencing the dominant recharge period in autumn and winter.
249 Accordingly, we have added the relevant content to the caption of Fig. 9, as detailed below:

250 “Most recharge events occur from October to April, even when rainfall is not especially high, while
251 warm-season precipitation contributes little to recharge, likely due to increased evaporative losses
252 and shallow soil retention. Together, these patterns suggest strong seasonal control on recharge
253 processes, with effective infiltration primarily occurring during cooler, low-evaporation periods.”

254 We have specifically added the following content in the discussion:

255 “Additionally, the isotopic values of most groundwater in the gully areas are more depleted
256 compared to those of rainfall and pond water, likely due to the recharge mechanisms and residence
257 times of different groundwater types, and the inherent isotopic characteristics of their primary
258 recharge sources (Ouali et al., 2024). **The depleted signatures in groundwater reflect preferential**
259 **capture of isotopically light summer monsoon events, with effective percolation delayed to**
260 **cooler seasons due to transient soil storage and minimized evaporation, consistent with**
261 **observed water table rises predominantly from October to April.** Nevertheless, these values fall
262 within the range of precipitation isotopic values, leaning towards the more negative end. This
263 suggests two complementary mechanisms: (1) the thin unsaturated zone (<10 meters) provides
264 preferential pathways for rapid infiltration of precipitation, minimizing evaporative fractionation,
265 and (2) groundwater is likely recharged primarily by intense precipitation events (e.g., summer
266 storms) with inherently more negative isotopic signatures (Liu et al., 2024). Together, these
267 processes explain the observed isotopic characteristics of groundwater.”

268

269 7. The conceptual model (Fig. 10) emphasises the “restructuring” role of the gully system but does
270 not discuss the potential risks of associated pollutant transport. Given that related issues are

271 mentioned in the introduction, it is recommended to include a discussion on this aspect to present a
272 more comprehensive perspective.

273 **Response:** Based on your comment, the potential risks of pollutant migration have been added to
274 the discussion. It should be noted that, since this study does not involve the actual analysis of
275 pollutant migration, the related content is discussed solely as background and future research
276 directions. Therefore, the pollutant migration process is not explicitly represented in the conceptual
277 model (Fig. 10) and is addressed only in the textual discussion. The specific content is as follows:

278 “However, with the reconstruction of gully systems and ecological restoration, attention must also
279 be given to the potential risks of pollutant migration (Yu et al., 2020). The hydrological functions
280 of gullies may enhance the movement of pollutants into groundwater, especially in areas with
281 intensive human activities, where pollutants can enter engineered gullies through surface runoff and
282 subsequently infiltrate the groundwater system. During ecological restoration, excessive human
283 intervention or soil improvement measures may lead to the accumulation and dispersion of
284 pollutants, which may compromise groundwater security (Liu et al., 2017). Therefore, the protection
285 and rational reconstruction of gully systems should not only focus on their hydrological functions
286 but also consider potential environmental risks, particularly the pathways of pollutant migration.
287 These findings therefore underscore the need to evaluate gully-based restoration strategies within
288 an integrated water-quality and groundwater-protection framework (Obuobie et al., 2012; Zhao et
289 al., 2019; Zhao et al., 2021; Xue et al., 2025).”

290 **References**

291 Liu, Y.S., Chen, Z., Li, Y., Feng, W., Cao, Z. The planting technology and industrial development
292 prospects of forage rape in the loess hilly area: A case study of newly-increased cultivated land
293 through gully land consolidation in Yan'an, Shaanxi Province. *Journal of Natural Resources*. 32:
294 2065-2074, 2017.

295 Yu, Y.L., Jin, Z., Chu, G.C., Zhang, J., Wang, Y.Q., Zhao, Y.L. Effects of valley reshaping and
296 damming on surface and groundwater nitrate on the Chinese Loess Plateau. *Journal of Hydrology*.
297 584: 124702, 2020.

298
299 8. The conclusion section (Section 7) provides a good summary of the study's core findings.
300 However, some statements appear slightly absolute, such as the claim to be “the first to

301 quantitatively identify the unique cascading recharge processes in a thin loess gully catchment"
302 (Lines 781-782). While the research is innovative, caution is advised with phrases like "the first."
303 It would be preferable to provide supporting literature references or adopt a more measured
304 description.

305 **Response:** Based on Reviewer #RC2's comment, we have revised the relevant phrasing to address
306 your concern. The specific revision is as follows:

307 "The study confirms that hydrologically arrested gully systems can function as critical "recharge
308 windows" for groundwater in arid areas. This underscores the importance of strategically identifying
309 and managing gully networks in watershed management, while avoiding excessive filling or
310 hardening to preserve their hydrological functions. In ecological restoration projects, directing
311 surface runoff toward engineered gullies under controlled conditions can efficiently convert limited
312 precipitation into groundwater storage, thereby enhancing regional water retention capacity. Beyond
313 advancing theoretical understanding of regional hydrological processes, this conceptual model
314 provides a process-based foundation for developing spatially targeted models of groundwater
315 recharge in managed dryland landscapes."

316
317 9. The manuscript is largely well-written, but some sections contain complex or awkward sentence
318 structures that could be improved for readability. For instance, the introductory and results sections
319 sometimes use dense scientific language, which might be simplified without losing technical
320 precision. Additionally, the formatting of the references section could be revisited for consistency.

321 **Response:** Thank you for your positive assessment of the manuscript and for the constructive
322 comments for improvement. We fully agree that enhancing clarity of expression and ensuring
323 formatting consistency are essential for both readability and scientific rigor. In response to your
324 comments, we have implemented the following comprehensive revisions:

325 First, we thoroughly reviewed the entire manuscript, with particular emphasis on the
326 Introduction and Results sections, and systematically revised sentences with complex structures or
327 awkward phrasing. While preserving scientific accuracy and completeness, we improved clarity and
328 fluency by breaking up long sentences, refining sentence structure, and optimizing the density of
329 technical terminology.

330 Second, in accordance with the journal's guidelines, we carefully checked and standardized all

331 in-text citations and the reference list to ensure full compliance. In addition, following your Specific
332 Comment 10, we have incorporated the recommended key references into the manuscript.

333 We believe these targeted revisions have substantially improved the clarity, readability, and
334 formatting consistency of the manuscript.

335

336 **10. Some important references are missing from the introduction and discussion sections:**

337 De Vries, J. J., & Simmers, I. (2002). Groundwater recharge: an overview of processes and
338 challenges. *Hydrogeology Journal*, 10(1), 5-17.

339 Huang L.M., Shao M.A., Advances and perspectives on soil water research in China's Loess Plateau.
340 *Earth-Science Reviews*, 2019: 102962.

341 Huang, L.M., Wang, Z.W., Pei, Y.W., Zhu, X.C., Jia, X.X., Shao, M.A., Adaptive water use strategies
342 of artificially revegetated plants in a water-limited desert: A case study from the Mu Us Sandy Land.
343 *Journal of Hydrology*, 2024, 644: 132103.

344 Xiang, W., Si, B. C., Biswas, A., & Li, Z. (2019). Quantifying dual recharge mechanisms in deep
345 unsaturated zone of Chinese Loess Plateau using stable isotopes. *Geoderma*, 337, 773-781.

346 **Response:** We have carefully verified that the recommended references have been added or
347 appropriately cited in the manuscript. We fully agree that including these important references
348 significantly enhances the breadth and rigor of the study, and we have standardized the citation
349 format in accordance with the journal's guidelines.

350 **References**

351 Huang L.M., Shao M.A. Advances and perspectives on soil water research in China's Loess Plateau.
352 *Earth-Science Reviews*. 199(2): 102962, 2019. DOI: 10.1016/j.earscirev.2019.102962.

353 Huang, L.M., Wang, Z.W., Pei, Y.W., Zhu, X.C., Jia, X.X., Shao, M.A. Adaptive water use strategies
354 of artificially revegetated plants in a water-limited desert: A case study from the Mu Us Sandy Land.
355 *Journal of Hydrology*. 644: 132103, 2024. DOI: 10.1016/j.jhydrol.2024.132103.

356 Vries, J.J.D., Simmers, I. Groundwater recharge: an overview of processes and challenges.
357 *Hydrogeology Journal*. 10(1): 5-17, 2002. DOI: 10.1007/s10040-001-0171-7.

358 Xiang, W., Si, B.C., Biswas, A., Li, Z. Quantifying dual recharge mechanisms in deep unsaturated
359 zone of Chinese Loess Plateau using stable isotopes. *Geoderma*. 337: 773-781, 2019. DOI:
360 10.1016/j.geoderma.2018.10.006.