Response to the comments on the manuscript (HESS-2024-387) **"Mapping mining-affected water pollution in China: Status, patterns, risks, and implications"** by Ziyue Yin, Jian Song, Dianguang Liu, Jianfeng Wu*, Yun Yang, Yuanyuan Sun, and Jichun Wu.

Note that the following text in Arial Narrow font denotes Referee's comments and in Times New Roman font denotes our response to the comments in the review. In our resubmission, the marked PDF file (HESS-2024-387_R1_marked.pdf and Supplement_R1_marked.pdf) has clearly indicated all changes to the original manuscript, tables and figures. Also, in our marked PDF file, marked in ~~a green strikethrough font~~ is the text that should be removed from the original manuscript and marked in a red font is the text that has been added to the current revision. In addition, Line number(s) mentioned below can be referred to as that line numbering in the marked revised manuscript.

Response to Referee #1's Comments

Human activities of mining have profound impacts on water quality at local to regional scales. In this paper, the attention is paid to mapping mining-affected water pollution in China. It is achieved through the compilation of a number of publicly available surface water and groundwater datasets. In general, the paper can be valuable.

[Response] No change needed. We sincerely appreciate your positive and insightful comments. Hereby we have fully addressed all of your concerns into the revised manuscript and made the necessary clarifications below.

There are three major comments for further improvement of the paper:

(1) There are various types of mining activities related to the exploitation of natural resources. Underlying the activities are the spatial distribution of natural resources. For example, metals and minerals are of different distributions in China and as a result, the respective mining activities are in different places and of varying intensity. It seems that the paper does not present the big picture of spatial distributions of natural resources. Accordingly, the plot in Figure 1 is patchy, rather than comprehensive. Therefore, the authors may want to explicitly illustrate spatial distributions of natural resources as a big context of the literature survey work for the paper.

[Response] We appreciate your comment and have incorporated the suggestions into the revision. The belief information on natural resources in China has been presented in the revised manuscript (**Lines 95-102**) and in Section S1 of the **Supplement** (**Lines 16-57**), which serves as the cornerstone for the database development, spatial pattern analysis, and risk assessment in the study. Specifically, Figs. S1 and S2 illustrate the spatial distribution and total sulfur content of coal-bearing areas in China, and Fig. S3 exhibits the spatial distribution of the major non-ferrous mineral resources in China.

China, the second-largest economy worldwide, has various and extensive mineral resources (Li et al., 2014). It has been demonstrated that there are 171 types of mineral resources in China, with proven reserves accounting for 12% of the world's mineral resources (Hu et al., 2009). Furthermore, China is one of the largest global producers and consumers of metals and metalloids, such as Fe, Mn, Zn, Pb, Sb, and Sn (Gunson and Jian, 2001). China's coal reserves of 143,197 million tons (Mt) rank fourth globally, while its annual production of 2,971 Mt leads worldwide (Blowes et al., 2014; Ai et al., 2023).

The spatial distribution of coal fields shows significant regional differences, with dense concentrations in the coal-bearing areas of North and South China (Fig. S1). Among them, the southern Inner Mongolia, Shaanxi, Shanxi, and Henan provinces have the highest density of coal mines and mine production capacity. Besides, the coal resources of the junction of Anhui and Shandong provinces as well as Yunnan, Guizhou, Sichuan, and other provinces in southwest China are relatively rich (Xiao et al., 2021).

As shown in Fig. S3, China is rich in non-ferrous metal mineral resources. The predominant types are copper, lead-zinc, tin deposits, etc., mainly distributed in provinces such as Jiangxi, Yunnan, and Inner Mongolia. For example, the Dexing copper mine in Jiangxi province ranks as one of the largest copper deposits in China, while the Gejiu tin mine in Yunnan province is a world-renowned tin-producing area. Additionally, substantial precious metal mineral resources (gold and silver deposits) are predominantly located in Shandong, Henan, and Guizhou provinces. For example, the Zhaoyuan gold mine in Shandong province is a historically significant gold-producing region.

It is noteworthy that the national mineral deposit database of China developed by Li et al. (2019), covering 232 mineral resources in 27,569 deposits in 29 provinces (cities or districts), is of great importance to study the national natural resources. It can help readers catch more authoritative information, such as ore species, deposit name, location, latitude (N), longitude (E), genetic type of deposit, paragenetic mineral, associated mineral, deposit scale, ore-forming age, and mining status, enabling comprehensive analysis of China's natural resources.

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(2) It is known that the mining of coal has a considerable impact on water quality, especially in West China. On the other hand, there is a lack of in-depth investigation of coal mining. Given the importance of coal mining and the existence of extensive studies, the authors may want to present a detailed analysis.

References:

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Qu, S., Liang, X., Liao, F., Mao, H., Xiao, B., Duan, L., Shi, Z., Wang, G. and Yu, R., 2023. Geochemical fingerprint and spatial pattern of mine water quality in the Shaanxi-Inner Mongolia Coal Mine Base, Northwest China. Science of The Total Environment, 854, p.158812.

[Response] Thank you for your constructive suggestions. An in-depth analysis of the considerable impacts of coal mining activities on water quality has been added to the revised manuscript based on the results obtained from the following references (**Lines 100-105**, **Lines 551-555**, and **Lines 559-564**):

Coal is the predominant energy source for both domestic and industrial use in China, with reserves of 143,197 million tons (Mt) ranking fourth globally, while its annual production of 2,971 Mt leads worldwide (Blowes et al., 2014; Ai et al., 2023). However, coal extraction inevitably generates substantial amounts of mine water, resulting in a series of water environmental issues (Zhang et al., 2016; Qu et al., 2023). Current estimate shows a 2:1 mine water to coal production ratio, with approximately 2 tons of mine water produced per ton of extracted coal in China (Gu et al., 2021). Coal mining activities, especially those involving sulfide-rich coal mining, are intrinsically associated with acid mine drainage (AMD). Our investigation in this study focuses on mining regions in northern and southwestern China, which account for approximately 70% of the national coal production. The spatial hotspots of mining-affected water pollution are mainly distributed in the southern regions, especially in Guizhou, Guangdong, Fujian, Jiangxi, Hunan, and Guangxi provinces/autonomous regions. As illustrated in Fig. S2, the coal fields in China exhibit sulfur contents ranging from 0.02% to 10.48%, with South China's coal-bearing areas showing the highest weighted average sulfur content (2.35%), including 29.63% of high-sulfur coal. Comparatively, those weighted average sulfur contents of coal-bearing areas in Tibet-Western Yunnan, North China, and Northeast China are 0.94%, 0.88%, and 0.86%, respectively (Tang et al., 2015). The main sulfide minerals in mine wastes are pyrite (FeS_2) and pyrrhotite ($Fe_{1-x}S$), while other associated sulfides are prone to oxidation and release toxic elements, including Al, As, Cd, Co, Cu, Hg, Ni, Pb and Zn, into the water flowing through the mine tailings (Blowes et al., 2014). Consequently, mining-affected water is characterized by the presence of diverse contaminants, including excessive sulfate, fluoride, and toxic heavy metals (Sun et al., 2020; 2025).

Gu, D.Z., Li, J.F., Cao, Z.G., Wu, B.Y., Jiang, B.B., Yang, Y., Yang, J., Chen, Y.P.: Technology and engineering development strategy of water protection and utilization of coal mine in China. J. China Coal Soc., 46(10), 3079-3089 (in Chinese with English abstract), https://doi.org/10.13225/j.cnki.jccs.2021.0917, 2021.

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(3) There are serious concerns on heavy metal pollution in recent years. Previously, there have been a few review papers. What new insights (findings) does this paper make?

References:

Cheng, S., 2003. Heavy metal pollution in China: origin, pattern and control. Environmental science and pollution research, 10, pp.192-198.

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Hu, H., Jin, Q. and Kavan, P., 2014. A study of heavy metal pollution in China: Current status, pollution-control policies and countermeasures. Sustainability, 6(9), pp.5820-5838.

[Response] The point is well taken. Based on your suggestions, we have reviewed the following references and cited them in the revised text and reference lists. Indeed, more than two decades ago, Cheng (2003) reviewed the sources of heavy metal pollution (*i.e.*, industrial emissions, wastewater irrigation, and waste fertilization) in the case sites, analyzed heavy metals in food and their transfer through the food web, and provided internationally available pollution control measures. About 10 years later, He et al. (2013) reviewed the status, sources, toxicity and potential risks, and possible reduction strategies of heavy metal pollution (especially for Pb, Hg, Cd, Cr, and As) in China. Also, Hu et al. (2014) reviewed the sources of heavy metal pollution (*i.e.*, waste gas, wastewater, and solid waste), discussed the policies (*e.g.*, the 12th Five-Year Plan on Prevention and Control of Heavy Metal Pollution) and challenges of controlling heavy metal pollution, and proposed corresponding countermeasures to mitigate heavy metal pollution by increasing the green GDP, reducing the heavy metals in fuel, using more renewable energy, and adopting market-based approaches.

Undoubtedly, the previous studies mentioned above have provided a solid basis for exploring the issues of heavy metal pollution originating from multiple pollution sources. In comparison to the previous studies, our study focuses on mapping mining-affected water pollution in China, elaborating on its status, patterns, risks, and implications. The new and unique contributions of the current study are: (i) establishing a national-scale high-quality database covering 8,433 surface water or groundwater samples (6,175 coal mine water samples and 2,258 metal mine water samples) from 298 mines (211 coal mines and 87 metal mines) in 26 provinces/autonomous regions of China; and (ii) filling the gap of the nationwide spatial patterns of water pollution and associated health risks from both coal and metal mining activities for the first attempt. Specifically, eight heavy metals (*i.e.*, Cr, Ni, Cu, Zn, As, Cd, Hg, and Pb) are considered in the current study based on a national-scale high-quality hydrochemical database. The new results show that Zn, Ni, and Cu are the predominant contaminations contaminants of both coal and metal mines in China. The detectable concentrations of several heavy metals are higher in most metal mines than in coal mines, especially in mining-affected water with low pH (< 6.5). The order of detectable median values of water affected by coal mining is Zn (0.4211) > Ni (0.1796) > Cu (0.0431) > Cr (0.0080) > Cd (0.0036) > As (0.0034) > Pb (0.0023) > Hg (0.0004), while that of water affected by metal mining is Zn (7.200) > Cu (1.7325) > Ni (0.2142) > Pb (0.1498) > Cr (0.0500) > Cd (0.0383) > As (0.0281) > Hg (0.0090). In terms of spatial patterns, the pollution hotspots and potential risks of mining-affected water (with low pH, high sulfate, Fe, Mn, and heavy metals) are pronounced in the southern regions, especially in Guizhou, Guangdong, Fujian, Jiangxi, Hunan, and Guangxi provinces/autonomous regions. These phenomena are closely linked to the underlying mechanisms, such as climatic conditions, geological factors, and mining practices. Accordingly, the findings of the study yield critical insights for designing differentiated management measures and formulating spatially-adaptive pollution control strategies across three key dimensions, including geographic scales (site-specific scale, provincial scale, or national scale), mine types (coal or metal), and mining status (active or abandoned). This multidimensional framework enables policymakers to strategically balance the trade-off between green mining activities and human health priorities (**Lines 743-771**).

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