Response to Comments on the Manuscript (essd-2023-66):

We deeply appreciate the detailed and constructive comments provided by the two anonymous reviewers during the second-round of review. Their suggestions and comments have been invaluable in refining our work, and we have carefully revised the manuscript and provided a point-to-point response to each comment.

The original comments are in **bold font**, our response is in regular font, and the changes in the text are in blue.

Response to Comments of Referee #1:

This revised manuscript proposes a gridded dataset detailing industrial water withdrawal (IWW) in China. In contrast to prior datasets, the dataset spans from 1965 to 2020, incorporating a seasonal cycle and showcasing enhanced spatial resolutions. Specifically, the seasonal variability refers to a dataset in the period 2006-2010, the spatial pattern refers to data from 2008, and subsequently, the collected provincial industrial IWW survey records from two other studies, which cover 1965 to 2020, are reconstructed into gridded maps based on the spatial and seasonal variabilities.

Following the first-round revision, incorporating feedback from three reviewers, improvements have been made to the paper. However, aligning with the concerns raised by the reviewers, who comprehensively covered my questions, I intend to provide my thoughts to the response of the authors. The current explanations remain unclear to me. While I acknowledge the overall strength of the study's motivation, reliance on these less-convincing assumptions does not effectively address the issues outlined by the authors in the introduction.

Response: Thank you very much for taking the time to review our manuscript and provide valuable feedback and comments. We appreciate your detailed thoughts on our assumptions on the spatialization and seasonality employed in developing industrial water withdrawal (IWW) data. Following your suggestions and comments, we added more supplement analysis to improve the confidence of the assumptions and revised texts to further clarify the assumptions and uncertainty of data.

Major:

Concern one: input spatial pattern of WUE (water use efficiency) from 2008 to represent the whole period from 1965 to 2020:

To support this assumption, the authors have replied that some models also utilized in time-invariant spatial patterns, and "spatial pattern of IWW is largely determined by the distribution of the population and economy of the country, which remain relatively stable over the years." I think the stable economic pattern can be only assumed for developed countries from 1965 to 2020, but for China, the spatial pattern in the last 60 years has tremendously changed, and IWW also depends on industry styles that have been updated and transferred from province to province substantially.

Response: Thank you for your comments and we would like to further clarify this important point.

The long-term gridded IWW data from 1965 to 2020 was developed by downscaling statistical IWW data based on the spatial-seasonal patterns of IWW in 2008. Although we could not directly incorporate the time-varying WUE at the grid level owing to the lack of such data, the provincial-level IWW statistical data have partially accounted for the changing spatial pattern of national IWW driven by economic development and changing WUE at the province level (Figure R1). For example, Shanghai's IWW was a significant proportion of the national total at an early time, but it declined sharply from 0.16 to 0.07 by the late 1970s. Similarly, the proportion of IWW in Heilongjiang and Liaoning gradually decreased between 1965 and 2020 (from 0.08 to 0.018 and 0.053 to 0.016 respectively). Conversely, the share of IWW in Jiangsu, Jiangxi, and Anhui exhibited a gradual increase between 1965 and 2020 (from 0.08 to 0.23, 0.004 to 0.05, and 0.02 to 0.08, respectively). The changing proportion of IWW of each province through time enables us to capture the changes in provincial-level spatial patterns. However, we acknowledge that this cannot track the changing spatial pattern of IWW within the province. We added Figure R1 to Figure I9 and modified the related sentence in the revision.

"The influence of other long-term factors such as climate change and WUE changes related to industry development could be partially captured by the provincial statistical data which incorporate the changing spatial pattern of total IWW at the provincial level (Fig. I9)."

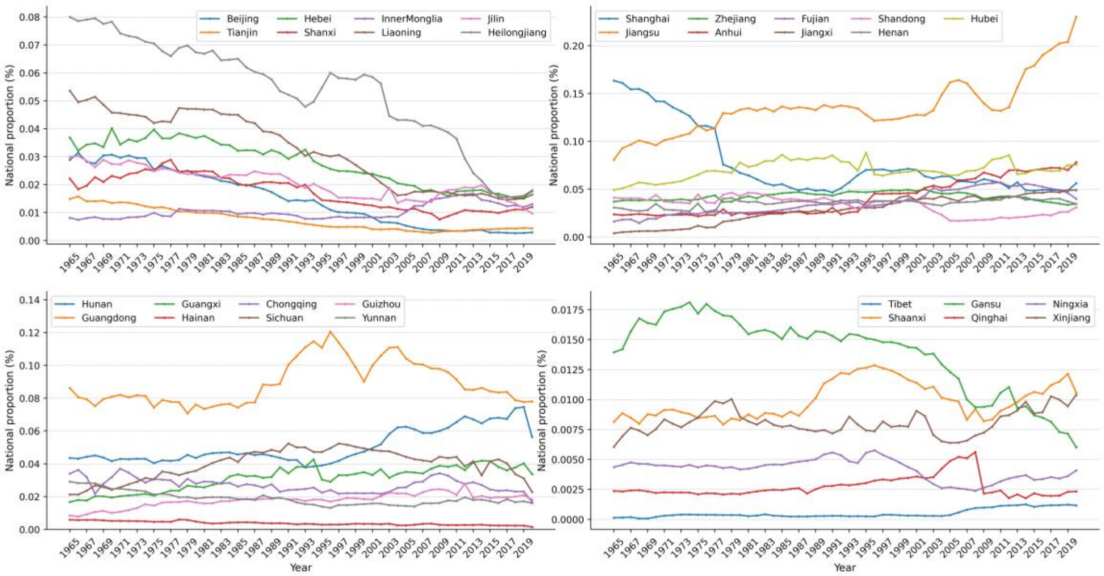


Figure R1/I9. The changing proportion of provincial IWW to national total from 1965 to 2020

Moreover, it is crucial to distinguish between "time-invariant input" and "input from a single year". In other words, even if the parameter is assumed to be time-invariant, the time-invariant pattern should be derived as the average across multiple years rather than from one single year.

In addition, I have double-checked the references the author cited, these models only mentioned the WUE increase but didn't explicitly give the reason why the time-invariant assumption is reasonable.

Response: In fact, the spatial-seasonal pattern of IWW in China would be different with the industrial development. Ideally, downscaling industrial water withdrawals using yearly-varying spatial-temporal patterns is the most desirable option, or to a lesser extent by using the time-invariant pattern derived from an average of multiple years. However, the China Economic Census Yearbook in 2008 is the only data source currently available for the subsectoral IWW over the past 60 years. The lack of data in other years keeps us from using the yearly varying or average of spatial-temporal patterns across multiple years. Therefore, we can only use the spatial-season pattern in 2008 to downscale the long-term provincial IWW. This choice is not perfect but we feel it is acceptable given the data limitation. Besides, the examples mentioned in the discussion such as WaterGAP3 (Flörke et al., 2013) and PCR-GLOBAL (Wada et al., 2011a, b) used the distribution of urban population and IWW from the single year to downscale calculations of long-term IWW data, while H08 (Hanasaki et al., 2008) used 5-year distribution of population for calculating the long-term data. In these model data, increasing WUE was used to estimate changes in IWW globally, but not for the spatial downscaling of long-term data. In the revision, we revised the text to specify what "time-invariant" means.

"We acknowledge that the time-invariant spatial-seasonal pattern of IWW from a single year in 2008 was a strong assumption and probably not true in reality. Nevertheless, this practice was acceptable in the literature under the data limit. For example, the spatial patterns from a single year (e.g., the urban population distribution in 2009 used in WaterGAP3 and Global IWW map in 2000 used in PCR-GLOBAL) or patterns with multi-year updates (e.g., H08 and Huang et al., 2018) were both used when developing the gridded IWW data with long time spans."

Table R1 Spatial pattern used to derive long-term data in previous studies

Spatial pattern	Long-term data	Used for	References
Distribution of urban population in 2009--Input from a single year	1950-2010	Model (WaterGAP3)	Flörke et al., 2013
Global IWW map in 2000--Input from a single year	1960-2001	Model (PCR-GLOBWB)	Wada et al., 2011a, b
Global population distribution map (1990, 1995, 2000) and national boundary information in 2005	1970-2010	Model (H08)	Hanasaki et al., 2008
Global population density maps with decadal updates (1980, 1990, 1995, 2000, 2005)	1970-2010	Global gridded monthly sectoral water use dataset	Huang et al., 2018

Additionally, the authors mentioned the unavailability of the data in other years, but why Yearbooks of China in other years did not provide such statistics?

Response: Thank you for giving us the opportunity to clarify this point.

The provincial-level subsectoral IWW data by 36 subsectors is from economic censuses (the China Economic Census Yearbook in 2008). Although China has conducted 5 economic censuses since 2004 (2004, 2008, 2013, 2018, and 2023 have not yet been released), only the 2008 China Economic Census data included national and provincial IWW by subsector. Besides, other statistical data sources did not have the IWW data with detailed subsectoral information as those in the 2008 China Economic Census data. Therefore, we only used 2008 data for our estimation. We modified the related sentence in the revision.

"To match the IWW survey data, which were only available in 2008 (the economic censuses in other years do not include detailed provincial IWW by subsector), industrial enterprise data in 2008 were selected for spatial downscaling of the provincial IWW (Fig. B2)."

Last but not least, the authors have provided discussion to state the high uncertainty of the proposed data in early years due to such assumption, but it would be helpful to give some quantitative analysis to prove how the uncertainty changed caused by inputting WUE pattern only from 2008.

Response: Following the reviewer's suggestion, we compared the three gridded IWW datasets (CIWW, Huang data, and model data) against Zhou2020 data at the prefecture level (whose information was not used in developing CIWW) to evaluate their uncertainty in earlier years. Results in Figure R2 show that CIWW clearly outperforms Huang and model data, with much higher correlation and smaller RRMSE (Relative Root Mean Squared Error, RMSE/mean) compared with Zhou2020 data, especially in the early years. This indicates that the performance of CIWW is still the best among the three despite the uncertainty. In the revised manuscript we added Figure R2 to Figure K11 and modified the related sentence:

"Users can select the time period of the dataset according to their specific needs and interpret earlier years' data with caution. Nevertheless, the CIWW data in earlier years showed surprisingly good performance with a much higher correlation (0.80 vs. 0.39~0.43 in 1971; as illustrated in Fig. K11) and smaller RRMSE (Relative Root Mean Squared Error, RMSE/mean, 1.81 vs. 2.67~ 2.76 in 1971) than other datasets when compared against Zhou2020 data at prefectural level (Note the prefecture-level IWW from Zhou2020 data was not used in developing CIWW)."

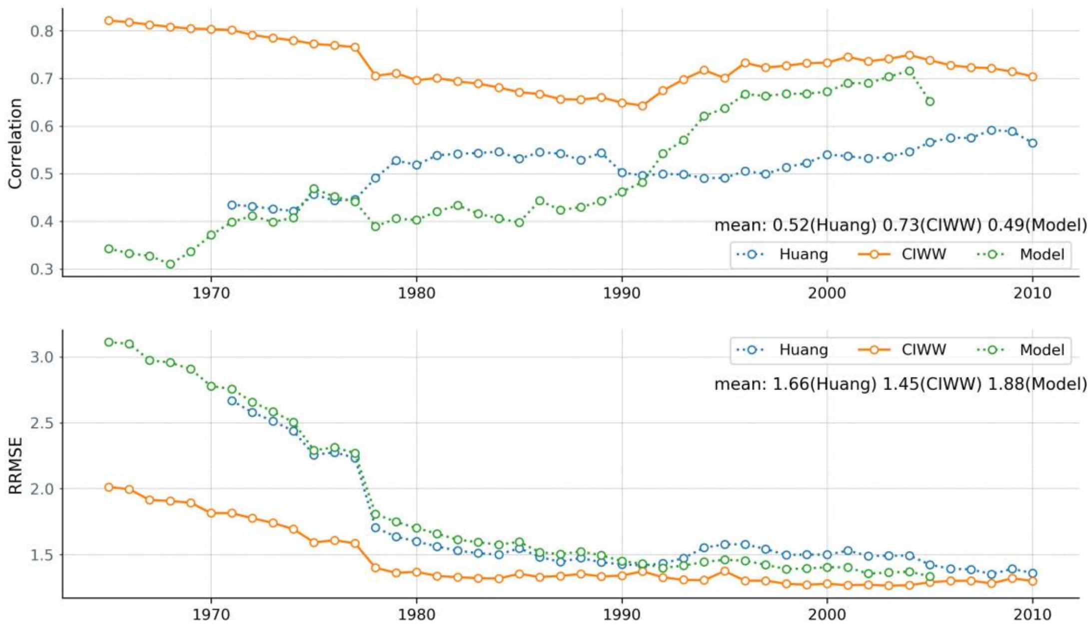


Figure R2/K11. Comparing the three gridded IWW (CIWW, Huang data, and model data) against Zhou2020 data at the prefecture-level from 1965 to 2010. Higher is better for correlation, and lower is better for RRMSE (Relative Root Mean Squared Error, RMSE/mean).

Concern two: The validation data in Figure 2 is not independent from the input data,

despite their differing scales. I recommend incorporating additional physically relevant variables for comparison with the proposed CIWW. This comparative analysis, both spatially and temporally, would demonstrate the new dataset's responsiveness to independent data sources and its potential utility for scientific analysis.

Response: Thank you for the comments.

It would be great to have other independent IWW data or physically relevant variables for validation. Unfortunately, such data might still be lacking and we could not find usable data after searching. We look forward to making more comparisons if relevant IWW data come out in the future. Given the data constraint, we deliberately used the provincial-level IWW of Zhou2020 data to develop the CIWW data while leaving the prefectural-level data only for validation. Although prefectural-level and provincial-level IWW are not considered to be completely independent (each province consists of many prefectures), the spatial variations in prefecture-level IWW at a finer scale are not captured by the provincial IWW. In the absence of additional data, this prefectural IWW can support the validation of existing datasets in China. Following this suggestion, we revised the sentence in section 2.3:

"Although we used the Zhou2020 data at the provincial level to produce the CIWW dataset, the prefectural-level data were unused in developing CIWW but left intentionally only for validation purposes. The provincial- and prefectural-level IWW are not completely independent (each province consists of many prefectures), however, the intra-provincial variations reflected in prefectural IWW are not captured by the provincial IWW. In the absence of additional validation data, the prefectural IWW can support the validation and determine the effectiveness of spatial downscaling."

Concern three: The weaker seasonal pattern observed in the proposed data's seasonal cycle (depicted by the blue line in Figure 2b) is shown, which is mainly caused by overestimated values in winter. Could you please provide further details or insights into the reasons behind this observation?

Response: Thank you for giving us the opportunity to clarify this point.

Since seasonal variations of CIWW are derived from the monthly fraction of national subsectoral industries and IWW, reflecting the seasonality at the national level (except Electricity and Heating Power Production and Supply subsector which used regional different seasonality in the revised manuscript). The national seasonal variation applied in Beijing may not fully capture local variations. The overestimated IWW in December could be caused by a combination of the high heating energy demand and the increased output of manufacturing stimulated by international trade. We added this supplement in the 2.3 section.

"The results showed that both the CIWW and Huang data could capture the 5-year mean seasonality of IWW in Beijing (Fig. 2b). The slight deviation of CIWW from statistical data in certain months (e.g., December) reflects the imperfect capability of applying national seasonality to characterize local variations in Beijing."

Concern four: Figure 5, any explanation for the IWW decrease at a country level after 2010?

Response: Thank you for giving us the opportunity to clarify this point.

The decline of national IWW after 2010 is mainly due to the implementation of a series of water-saving management measures (The State Council of the People's Republic of China, 2011) such as establishing "three red lines" to cap the total water withdrawal, enhance water use efficiency (WUE), and restrict pollutants in water function areas. As a result, the industrial recycling water rate exhibited a gradual increase over time from 85.7% in 2010 to 92.5% in 2020 (Chen and Chen, 2021), while the industrial water use intensity gradually decreased from 90 in 2010 to 32.9 in 2020 (unit: m^3/10000 yuan) (Zhang et al., 2023).

To explain the decline in national IWW, we added an implementation in the revision.

"These long-term changes indicated that IWW in China has now entered a slowly declining phase. The decline of national IWW after 2010 is mainly due to the implementation of a series of water-saving management measures (The State Council of the People's Republic of China, 2011) such as establishing "three red lines" to cap the total water withdrawal, enhance water use efficiency, and increase industrial water recycling rate (Chen and Chen, 2021; Zhang et al., 2023)."

There is input replacement before and after 2002, whereas the result in Fig 5 shows a perfectly smooth temporal variation, any process regarding this input replacement? Only because the two input datasets well match each other?

The statistical data of IWW consists of two sources: Zhou2020 data for 1965-2013 and China Water Resources Bulletin for 2003 afterward. During the overlap periods, the national IWW from the two data sources was almost identical (117.72 vs 118.86 unit: km^3) in 2003 (Figure 3R) but started to diverge for the rest years. We opted for the China Water Resources Bulletin starting from 2003 as the data source because it is being updated continuously. Therefore, the monthly national IWW exhibits a smooth curve, as shown in Figure 3R. In the revised manuscript we added Figure R3 as Figure C3 and a more detailed description in the section of data as follows:

"The national IWW between two sources (Zhou2020 data and China Water Resources Bulletin) was almost identical in 2003 (117.72 vs 118.86 unit: km^3; Fig. C3) but started to diverge afterward. To ensure data continuity, we opted for the China Water Resources Bulletin starting from 2003 as a statistical data source because it has been updated continuously since then. Thus, the combination of the above two data sources provided complete and continuous statistical records of IWW from 1965 to 2020 in China."

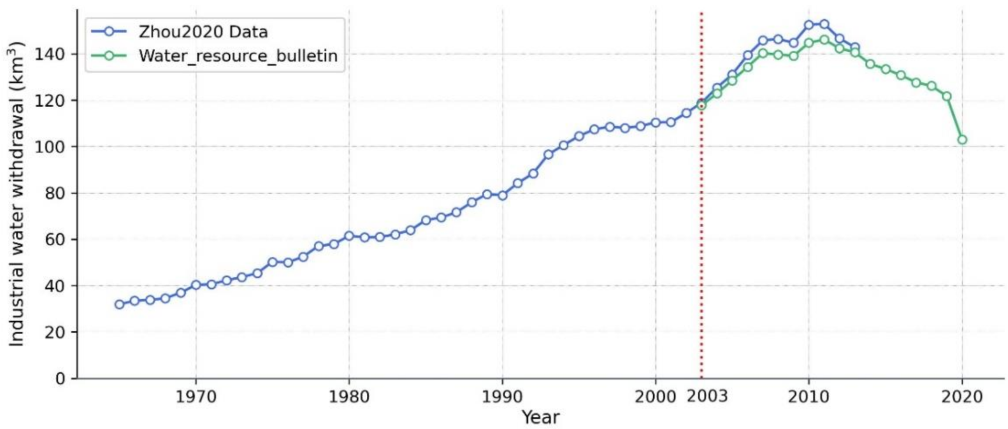


Figure R3/C3. The national IWW from two statistical data sources.

As you already aggregated the data variation analysis to country and decade scales, what are other IWW data performances in this analysis? A comparison is still needed.

Following the reviewer's suggestion, we plotted the long-term monthly/annual national IWW of CIWW, Huang and model data (monthly data unavailable) together (Figure 4R). The comparison indicates that the other two datasets overall underestimated China's total IWW. We also added the comparison results in the revision.

"In addition, the comparison of long-term annual national IWW of three datasets (CIWW, Huang and model data) showed that the other two datasets significantly underestimated China's total IWW and presented different temporal patterns, which could not consider the effects of water use policies (Fig. H8).

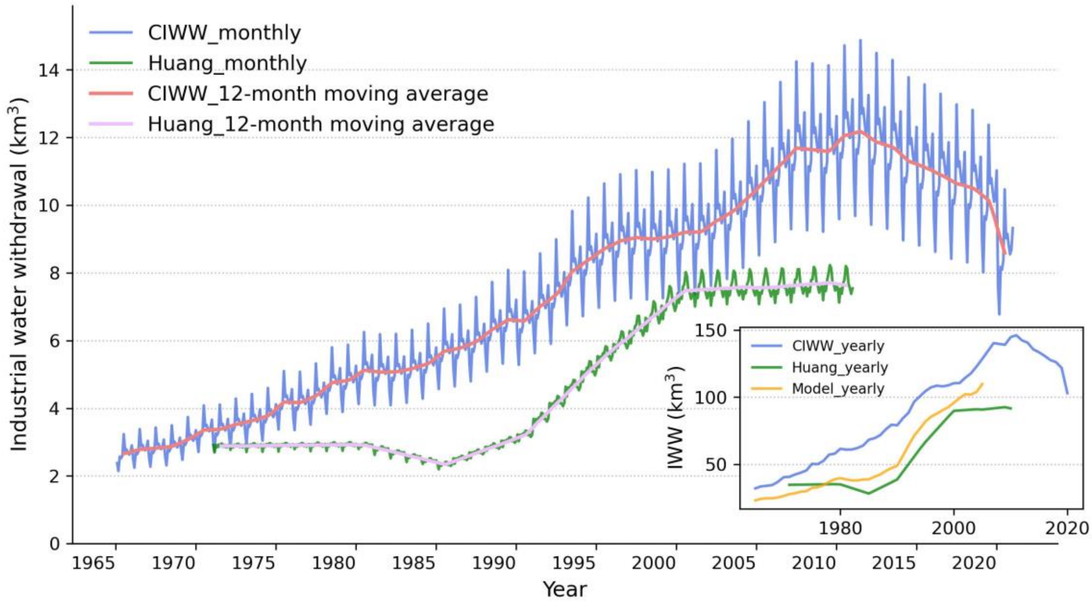


Figure 4R/H8 Monthly and yearly IWW in China from 1965 to 2020 from the CIWW, Huang and model data.

Minor:

(1) Line 24: I understand you would like to point out the definition distinction between IWW and water consumption, but this sentence reads like "IWW in this study doesn't include water consumption part".

Response: Thanks for kindly reminding us of this issue.

We modified this sentence and the revised texts are shown below:

"Industrial water withdrawal (IWW) is the amount of water abstracted from fresh water sources for industrial purposes, which is different from water consumption;"

(2) Figure 6 d-f: it is really difficult to find scatters and corresponding colors on these three subplots.

Response: Thank you for the comments. We revised panel d-f of this figure to show results at 0.02° resolution to improve readability. The revised Figure 6 is as follows:

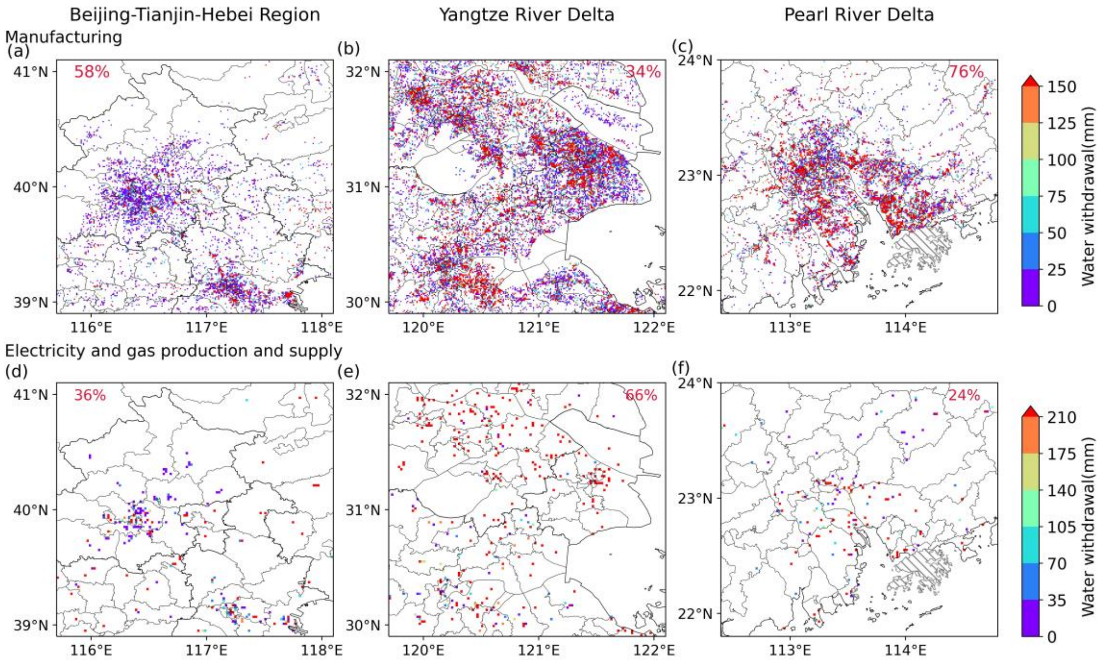


Figure 5R/6. Zoomed view of IWW in the densely urbanized regions in China at a spatial resolution of 0.01° (a, b, c) and 0.02° (d, e, f) for clarity, including the Beijing-Tianjin-Hebei region (a, d), Yangtze River Delta (b, e), and Pearl River Delta (c, f). Panels (a)–(c) show the spatial pattern of IWW for manufacturing, and Panels (d)–(f) show the spatial pattern of IWW for electricity and gas production and supply. The numbers displayed as percentages denote the percentage of the sectoral IWW to total IWW.

Response to Comments of Referee #2:

This manuscript developed a gridded dataset of monthly industrial water withdrawal in China from 1965 to 2020, with a spatial resolution of 0.1°and 0.25°. While the temporal and spatial coverage of the dataset is extensive, I have some minor reservations regarding the spatialization method employed in the study. I'd suggest to address these issues before acceptance for publication.

Response: We would like to sincerely express our gratitude to you for your careful reading and constructive comments. According to the comments, we have tried our best to improve the manuscript, and a point-by-point response follows.

1. My biggest concern is that the spatial distribution of industrial water use over a long time series is based on enterprise data from 2008. However, as economic development progresses and regional development trends, the spatial distribution of both enterprises and industrial water withdrawal is likely to change. These changes can potentially reduce the spatial accuracy of the long-term industrial water withdrawal data. Besides that, as you mentioned in the discussion section, the underlying assumption of this study is 'This improvement would occur for all enterprises', which means the water use efficiency of all enterprises has improved simultaneously. However, this assumption is highly uncertain and may not reflect the actual situation. Would there be other possible data sources you

can use to improve the situation? I'd highly recommend improving this.

Response: Thank you for your comment and your concern is legit.

Yes, using the spatial-seasonal pattern of 2008 to downscale multi-year IWW may affect the spatial accuracy of the long-term CIWW. We primarily made this decision due to data constraints, as there was no available data to estimate subsector or enterprises' water use efficiency for years other than 2008. Although we could not directly incorporate the time-varying WUE at the grid level, the provincial-level IWW statistical data have accounted for the changing spatial distribution of national IWW at the province level driven by economic development and changing WUE (Figure R1). For example, the proportion of IWW in Heilongjiang and Liaoning gradually decreased between 1965 and 2020 (from 0.08 to 0.018 and 0.053 to 0.016 respectively). Conversely, the share of IWW in Jiangsu, Jiangxi, and Anhui exhibited a gradual increase between 1965 and 2020 (from 0.08 to 0.23, 0.004 to 0.05, and 0.02 to 0.08, respectively). However, we acknowledge that this cannot track the changing spatial pattern of IWW within the province.

To evaluate the spatial accuracy in earlier years, we compared three gridded IWW datasets (CIWW, Huang data, and model data) against Zhou2020 data at the prefecture level (whose information was not used in developing CIWW) to evaluate their effectiveness in characterizing the spatial pattern of IWW. Results in Figure R2 show that CIWW clearly outperforms Huang and model data, with much higher correlation and smaller RRMSE (Relative Root Mean Squared Error, RMSE/mean) compared with Zhou2020 data, especially in the early years. This indicates that the performance of CIWW is still the best despite the uncertainty of water use efficiency.

In the revision, we added Figure R1 to Figure I9, Figure R2 to Figure K11, with further additional explanation in the discussion section.

"The influence of other long-term factors such as climate change and WUE changes related to industry development could be partially captured by the provincial statistical data which incorporate the changing spatial pattern of total IWW at the provincial level (Fig. I9)."

"Users can select the time period of the dataset according to their specific needs and interpret earlier years' data with caution. Nevertheless, the CIWW data in earlier years showed surprisingly good performance with a much higher correlation (0.80 vs. 0.39~0.43 in 1971, as illustrated in Fig. K11) and smaller RRMSE (Relative Root Mean Squared Error, RMSE/mean, 1.81 vs. 2.67~ 2.76 in 1971.) than other datasets when compared against Zhou2020 data at prefecture level (Note the prefecture-level IWW from Zhou2020 data was not used in developing CIWW)."

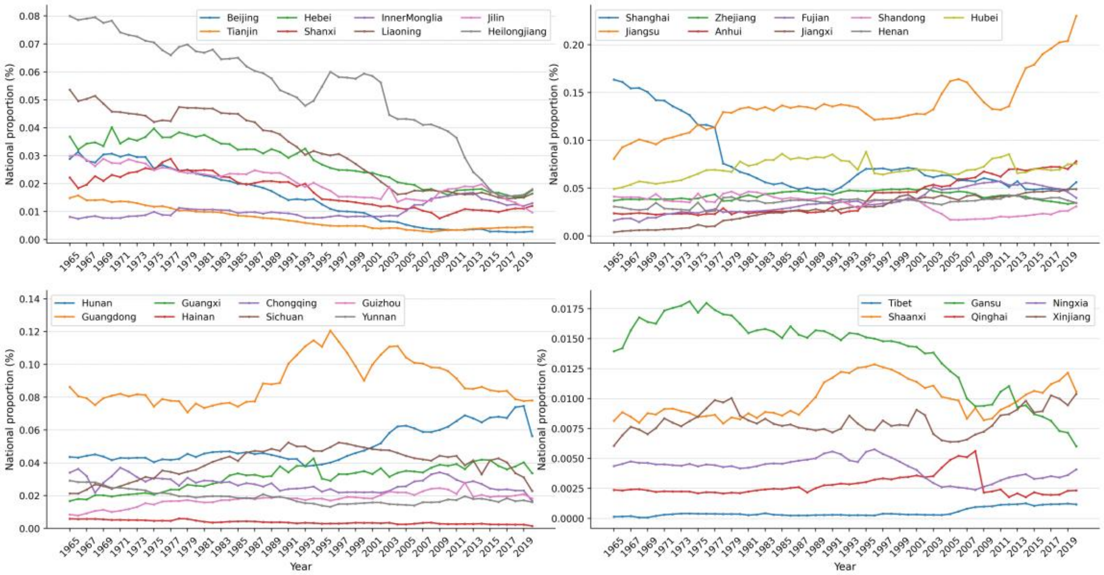


Figure R1/I9. The changing proportion of provincial IWW to the national total from 1965 to 2020

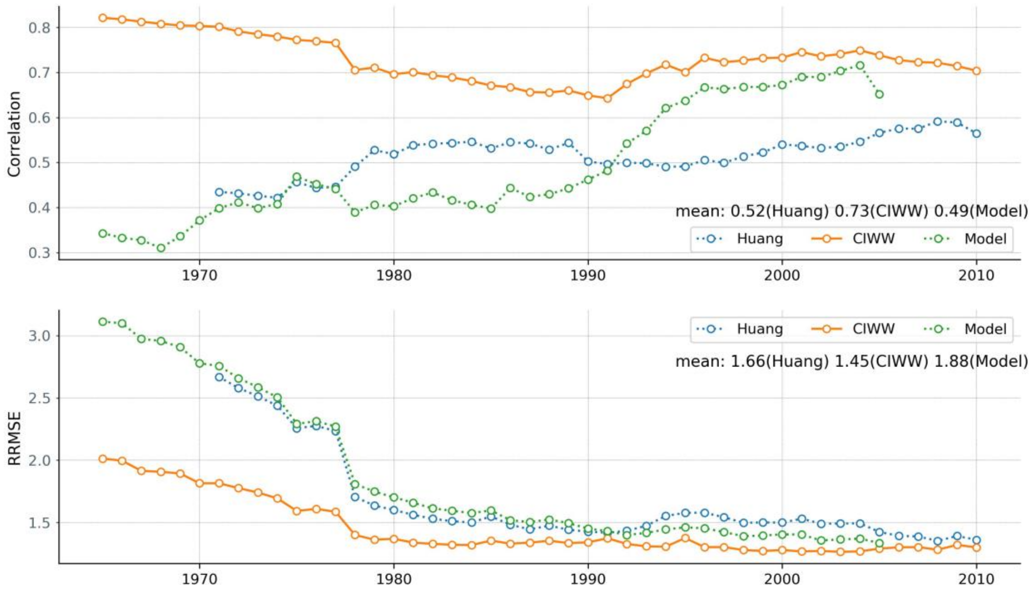


Figure R2/K11. Comparing the three gridded IWW (CIWW, Huang data, and model data) against Zhou2020 data at the prefecture-level from 1965 to 2010. Higher is better for correlation, and lower is better for RRMSE（Relative Root Mean Squared Error, RMSE/mean）.

2. The China Water Resources Bulletin is available starting from 1997. However, in this study, only statistical data from 2003 to 2020 were used and merged with Zhou2020 data from 1965 to 2002. It is important to understand the rationale behind this decision. Regarding the merging of data with Zhou2020 dataset, it is essential to provide a relatively detailed explanation of Zhou2020 data and the methodology used. This would enable readers to evaluate the reliability and relevance of the data.

Response: Thanks for kindly reminding us of this issue.

China’s Water Resources Bulletin has been published since 1997, however, the provincial IWW data needed by this study only became available continuously after 2003 (it was available in a few years such as 1999 and 2000 before 2003).

The Zhou2020 data (Zhou et al., 2020) integrate multiple versions of water resources survey data (1st and 2nd National Water Resources Assessment Program) and provide provincial/prefectural IWW from 1965 to 2013. During the overlap periods, the national IWW from the two data sources was almost identical (117.72 vs 118.86 unit: km^3) in 2003 (Figure R3) but started to diverge for the rest years. We opted for the China Water Resources Bulletin starting from 2003 as the data source because it is being updated continuously. Therefore, the monthly national IWW exhibits a smooth curve, as shown in Figure 3R.

In the revised manuscript we added Figure R3 as Figure C3 and a more detailed description in the section of data as follows:

"To further extend the time series to an earlier period, the IWW reported by Zhou et al., (2020) (referred to as 'Zhou2020 data' hereafter) from 1965 to 2002, was used after summing the prefecture data to the provincial level; its IWW was from multiple versions of water resources survey data (1st and 2nd National Water Resources Assessment Program) and defined the same way as the China Water Resource Bulletin and our study. The national IWW between two sources (Zhou2020 data and China Water Resources Bulletin) was almost identical in 2003 (117.72 vs 118.86 unit: km3; Fig. C3) but started to diverge afterward. To ensure data continuity, we opted for the China Water Resources Bulletin starting from 2003 as a statistical data source because it has been updated continuously since then. Thus, the combination of the above two data sources provided complete and continuous statistical records of IWW from 1965 to 2020 in China."

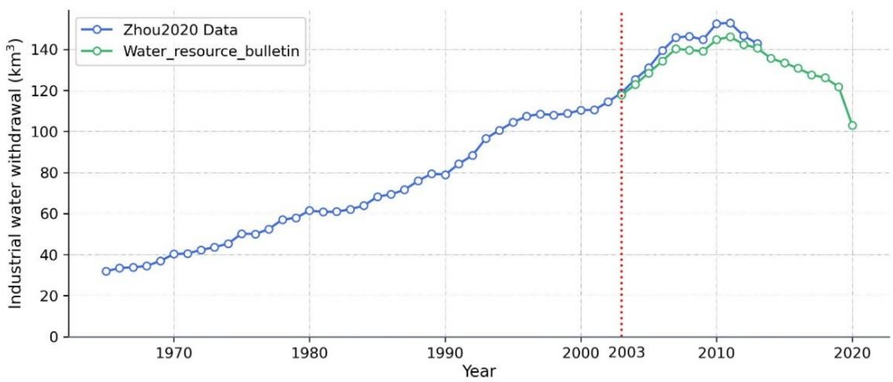


Figure R3/C3. The national IWW from two statistical data sources

3. As mentioned in the Introduction, the interannual variations of IWW due to seasonal variations and climate fluctuations are crucial. However, the methodology employed in your study, which utilizes a uniform monthly ratio for the entire country, might not adequately represent the seasonal variations among provinces, given the vast expanse of China. While the discussion section notes that seasonal differences between sectors are more significant than those between provinces, there can still be significant seasonal variations within sectors due to factors such as climate patterns and economic development. This is particularly relevant for the electricity and gas production and supply sector, which is a major consumer of industrial water and highly sensitive to water temperature and technologies. A nationwide uniform approach may introduce significant uncertainties in estimating monthly water withdrawal.

Response: Thanks for your constructive comments on this important point.

We agree that the seasonality of subsectors like Electricity and Heating Power Production and Supply is strongly linked to temperature seasonal variations of each province and thus may exhibit regional differences. Following the reviewer's suggestion, we further explored the different seasonality of IWW in the Electricity and Heating Power Production and Supply across provinces in China. We used the K-means method to cluster the seasonal variations into different spatial groups. The results showed that the seasonality in this subsector can be classified into three types, broadly corresponding to North China, South and Northwest China, and Xizang, respectively (Figure R4). The type 1 (15 provinces) seasonality has apparent two peaks around June and December, while type 2 peaked in JJA. Type 3 only includes Xizang whose seasonality looked different from other types. Shanghai, originally classified as type 1, was manually assigned to type 2 because of its strong peak in JJA.

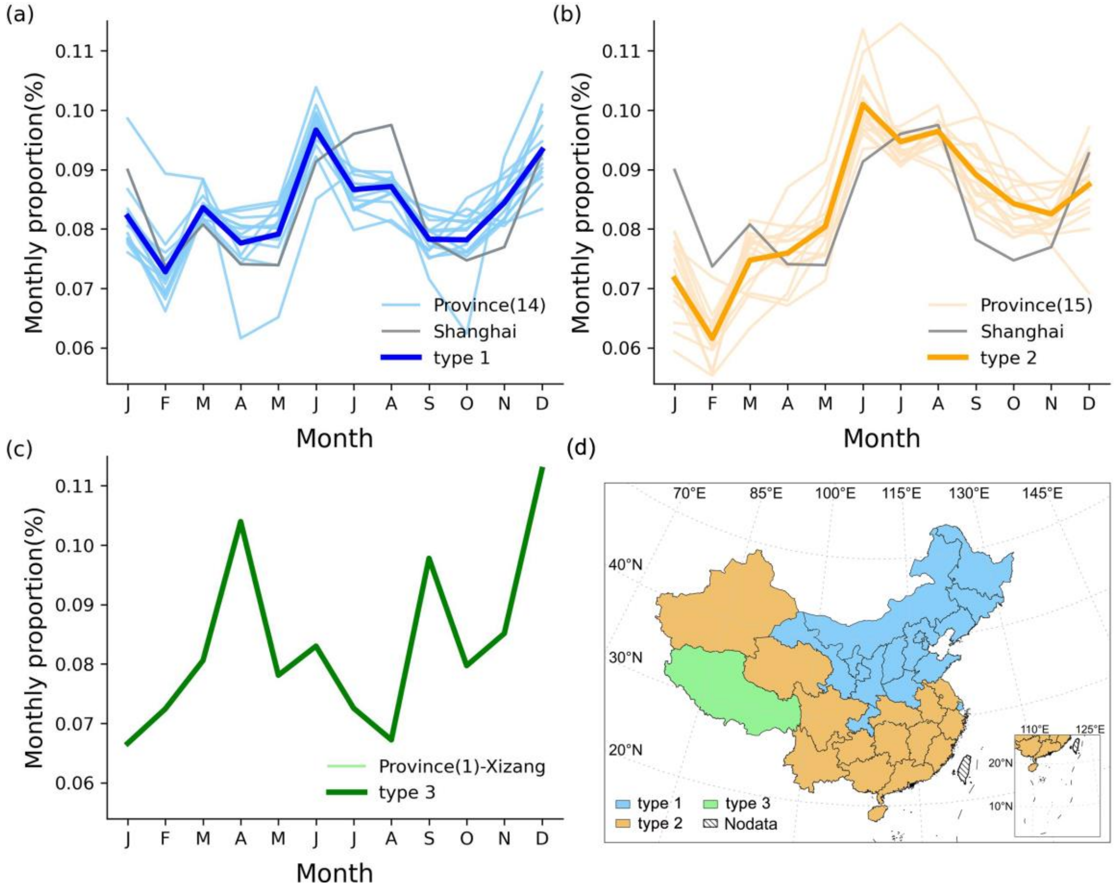


Figure R4/F5. Classification of seasonal variations of provincial water withdrawal of Electricity and Heating Power Production and Supply to type 1 (a), type 2 (b), type 3 (c), and d. map of three types. The seasonal variations are the faction of monthly IWW to the annual total during 2006-2010. The thick color lines show the mean seasonally of the cluster, and the thin color lines show the seasonally of each province.

Based on the clustering analysis, we recreated the CIWW data based on the updated seasonal variation of three types (North China, South and Southwest China, and Tibet) of the subsector——Electricity and Heating Power Production and Supply. Besides, we re-compared the CIWW data with updated seasonality against the statistical data for seasonal variation in Beijing

(Figure 4R) and the difference was subtle.

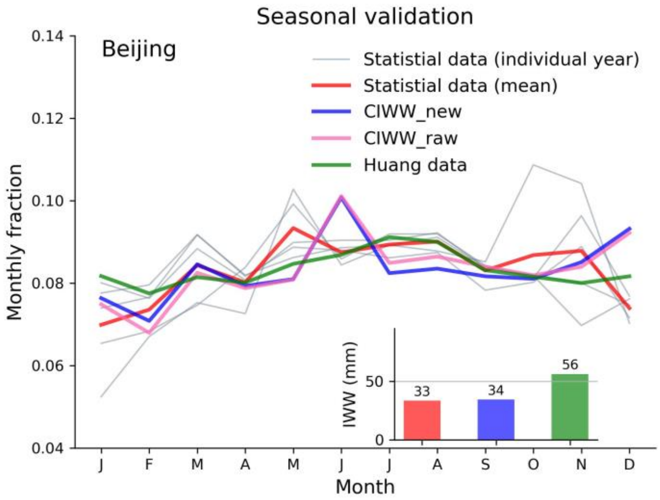


Figure R5/2b. Comparison of the 5-year mean (2006-2010) monthly variation in IWW from the surveyed statistical data (red, (Long et al., 2020)), update CIWW (blue), raw CIWW (pink), and Huang data (green) in Beijing. The solid grey line shows IWW for individual years from 2006 to 2010. The inset shows the annual mean total IWW from 2006 to 2010.

In the revised manuscript we updated Figure R5 as Figure 2b, added Figure R4 as Figure F6, and a more detailed description in the 2.2.2 section as follows:

"Instead of directly using the provincial-specific seasonal variations of the output data, the seasonal variations in each industrial subsector ($\mathrm{Fraction}_{mon,subs}^{water}$) were represented by the weighted mean of monthly product fractions across all provinces ($\mathrm{Fraction}_{mon,p,subs}^{output}$) with weights of provincial subsector IWW ($IWW_{p,subs}$) from the Chinese Economic Census Yearbook in 2008 (Eq. 3). The only exception is for Electricity and Heating Power Production and Supply (EPS) subsector because its seasonality is strongly linked to seasonal temperature variation of each province and thus may exhibit regional differences. To account for this issue, we used the K-means method and classified the seasonality of EPS into three types, which broadly correspond to North China (type 1), South and Northwest China (type 2), and Xizang (type 3), respectively (Fig. F6). In particular, Shanghai was manually adjusted from the originally classified type 1 to type 2 because of its strong peak in JJA."

4. Line203-205. The three models mentioned here may have different definitions for IWW. For instance, Water GAP considers the water withdrawal for thermoelectric power generation, while PCR-GLOBWB may not include such withdrawals. It is essential for the authors to clarify what type of data they are using from these models and whether their IWW definition aligns with the definitions used in the CIWW.

Response: Thanks for kindly reminding us of this issue.

The model data used for comparison is Input Data used in ISIMIP2b (https://www.isimip.org/gettingstarted/details/38/, last accessed: 18 March 2024), which is water abstraction for industrial uses of the multi-model mean (from Water GAP, PCR-GLOBWB, and H08) from 1901 to 2005. The definition of IWW in the three models is not the same. IWW in both H08 (manufacturing use and energy production) and PCR-GLPBWB means total IWW. Water GAP estimates manufacturing and energy water withdrawal separately and sums them to total IWW in the model simulation (Wada et al., 2016). All IWW in the model data does not include water withdrawals from the mining industry, but the impact would be small because mining only accounts for 5% of industrial water withdrawals according to statistical data.

To provide a clearer understanding of the data used for comparison, we have added a data introduction for comparison in the Data and Methods section.

"2.1.5 Other industrial water withdrawal data for comparison

There are two other gridded IWW datasets used to compare with the CIWW dataset: the global gridded monthly sectoral water use dataset for 1971-2010 at 0.5° (Huang et al., 2018) (referred to as 'Huang data' hereafter) and water abstraction for industrial uses from 1901 to 2005 at 0.5° as the input data for ISIMIP2b (referred to as 'model data' hereafter). The IWW from Huang data consists of three sectors: mining, manufacturing, and cooling of thermal power plants, and the sum of the three sectors was treated as the total IWW. The IWW from model data is the multi-model mean (Water GAP, PCR-GLOBWB, and H08). The sum of sectoral IWW (if available) was treated as total IWW. Unit of IWW was converted from m^3 to mm by dividing the grid cell area. Table D4 provides a summary of the data description used for comparison."

Table R2/D4 A summary description of other IWW data for comparison.

Data variable	**Data source**	**Industrial sector**	**Time span**	**Spatial resolution**
Industrial water withdrawal	Global gridded monthly sectoral water use dataset	Sectors (3)	Monthly, 1971-2010	0.5°
Water abstraction for industrial uses	Input Data used in ISIMIP2b	None	Yearly, 1901-2005	0.5°
Introduction of IWW between different models in model data				
IWW in model	**Industrial sector**	**Definition of IWW**		
Water GAP	Sectors (2, except mining)	Total IWW is the sum of manufacturing and energy production water withdrawal		
H08	None	Total IWW includes manufacturing use and energy production.		
PCR-GLOBWB	None	Total IWW no details available		

5. Line215-217. From Fig2(b), it appears that there are significant discrepancies between the monthly variation line of CIWW and the survey statistics data for Beijing. The author only demonstrates consistency with the survey statistics data by comparing the total annual quantities, without explicitly addressing the consistency in seasonal variations.

Response: Thank you for giving us the opportunity to clarify this point.

Seasonal variations of CIWW are derived from the monthly fraction of national subsectoral industries and IWW, reflecting the seasonality at the national level（except Electricity and Heating Power Production and Supply subsector which used regional different seasonality in the revised manuscript）. The national seasonal variation applied in Beijing may not fully capture local variations. The overestimated IWW in December could be caused by a combination of the high heating energy demand and the increased output of manufacturing stimulated by international trade. We added this supplement in the 2.3 section.

"The results showed that both the CIWW and Huang data could capture the 5-year mean seasonality of IWW in Beijing (Fig. 2b). The slight deviation of CIWW from statistical data in certain months (e.g., December) reflects the imperfect capability of applying national seasonality to characterize local variations in Beijing.

Additionally, relying solely on data from one city to validate the entire dataset may not be appropriate. It is advisable to select multiple representative cities to provide evidence for the reliability of the data.

Response: It would be great to have data in other cities to further validate seasonal variation of IWW, but unfortunately, we did not have the monthly IWW for other cities. We look forward to making more comparisons if relevant monthly IWW data come out in the future.

6. Line236-237. It may be necessary to supplement the analysis with a population distribution map or other relevant data to demonstrate the linkage between manufacturing water withdrawal and population. Additionally, Fig3(c) presents results based on 2008 data, and the authors must provide evidence to support the continuity of this conclusion over a long time period.

Response: Thank you for the constructive comments on this point.

Following the reviewer's suggestion, we displayed the population density maps of China every 5 years from 1990-2019 (Figure R5) (https://www.resdc.cn/doi/doi.aspx?doiid=32, last accessed: 18 March 2024), whose spatial distribution shows obvious similarity with the spatial distribution of manufacturing industry. Besides, given the development of the economy, the spatial pattern of population distribution remained stably over the nearly 30-year period from 1990 to 2019, indicating that the spatial pattern of manufacturing may remain relatively steady. In the revised manuscript we added Figure R5 as Figure G7.

"Water withdrawal from manufacturing broadly reflected the total IWW and population distribution of China, mainly showing the close linkage between manufacturing and population (Fig. 3c and Fig. G7)."

"These analyses support the fact that specific industrial enterprises, their WUE, and water withdrawal substantially changed over time, and the broad spatial pattern after aggregating to the grid scale can still be applied because the spatial pattern of IWW is largely determined by the distribution of the population and economy of the country, which remain relatively stable over the years (Fig. G7)."

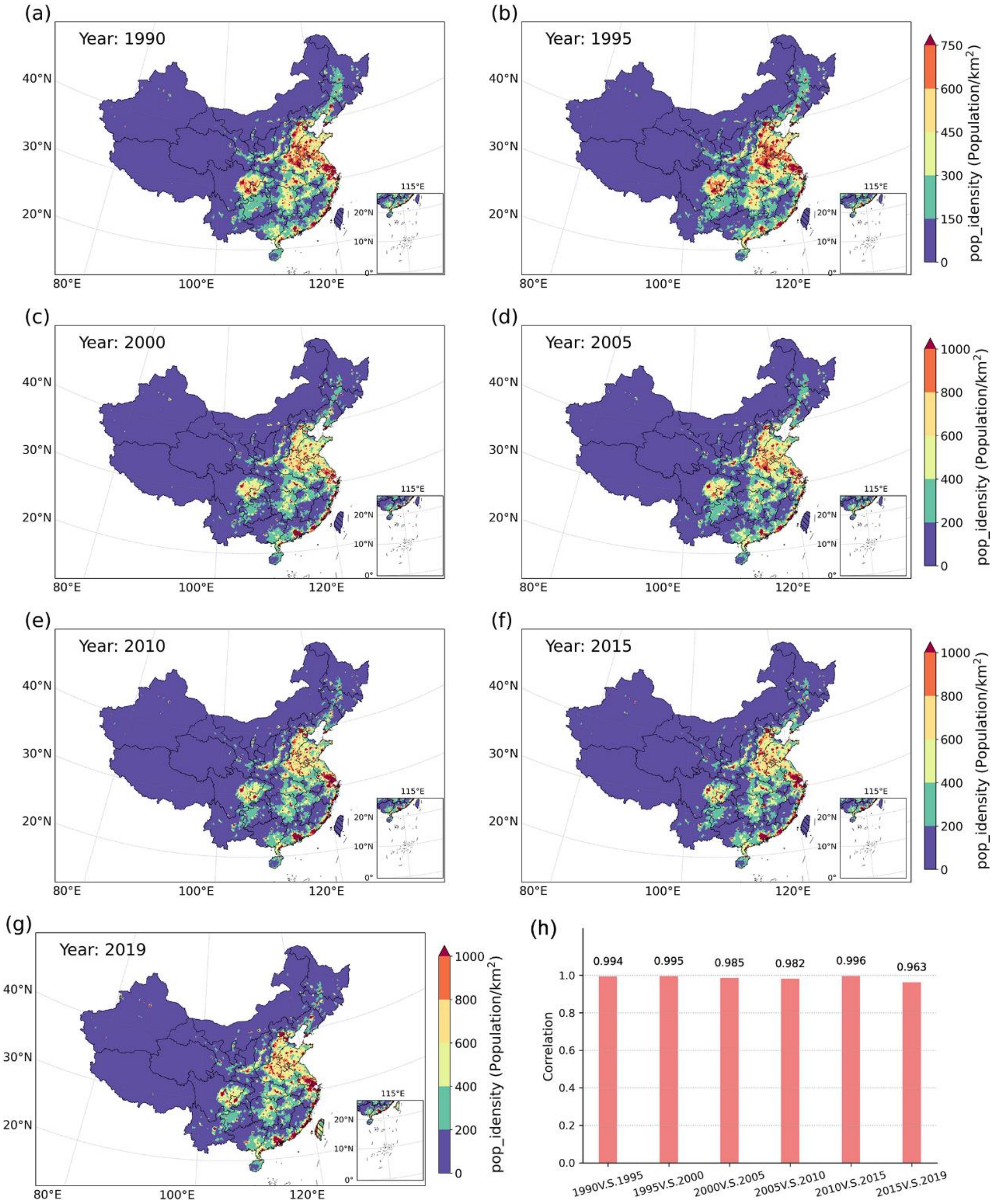


Figure 5R/G7. The distribution pattern of population density in China from 1990 to 2019 (a-g) and Spearman's rank correlation coefficients of population density spatial pattern from 1990 to 2019 (h).

7. In Fig3(b) and Fig6(d-f), the points on the graphs are not very clear, and it may be necessary to adjust the colorbar to make the results more distinct.

Response: Thank you for the comments. We revised panel d-f of this figure to show results at 0.02° resolution to improve readability. The revised Figure 6 is as follows:

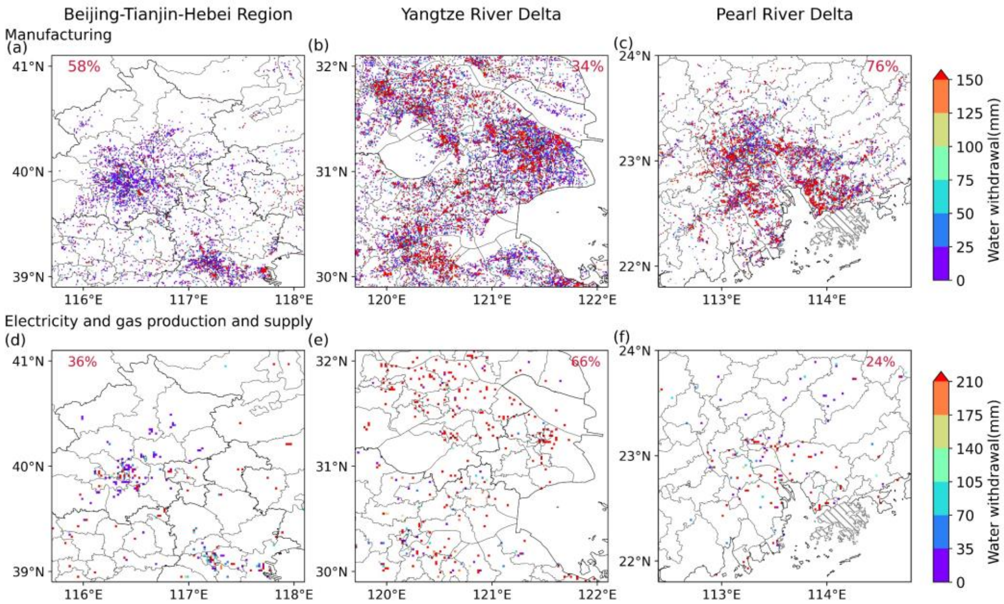
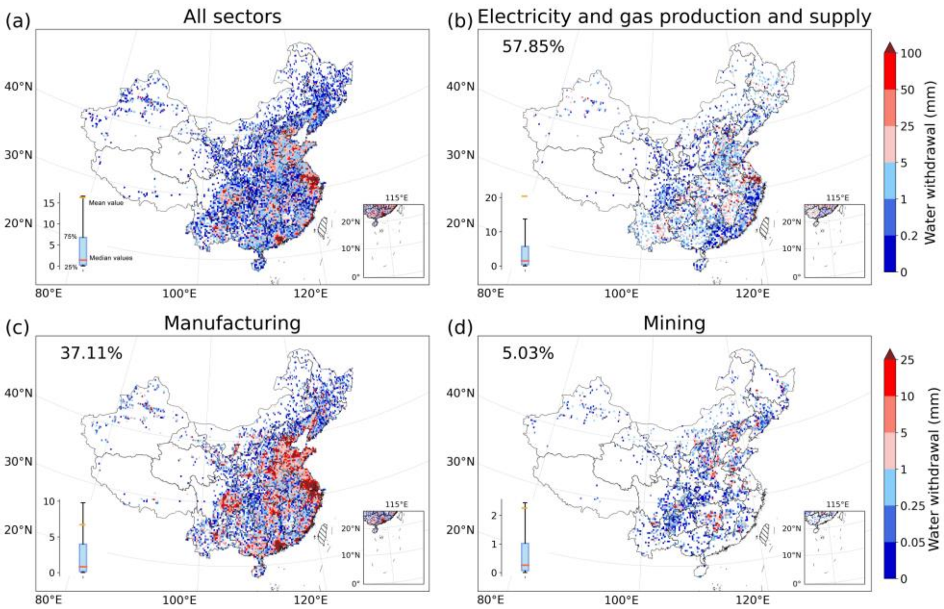


Figure 5R/6. Zoomed view of IWW in the densely urbanized regions in China at a spatial resolution of 0.01° (a, b, c) and 0.02° (d, e, f) for clarity, including the Beijing-Tianjin-Hebei region (a, d), Yangtze River Delta (b, e), and Pearl River Delta (c, f). Panels (a)–(c) show the spatial pattern of IWW for manufacturing, and Panels (d)–(f) show the spatial pattern of IWW for electricity and gas production and supply. The numbers displayed as percentages denote the percentage of the sectoral IWW to total IWW.

We uploaded a high-resolution version of Fig. 3(b) in the hope that it conveys the spatial information.



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