## Response to Comments on the Manuscript (essd-2023-218):

# The patterns of soil nitrogen stocks and C:N stoichiometry under impervious surfaces in China

Dear Editors and Referees,

Thanks for your comments on our study "The patterns of soil nitrogen stocks and C:N stoichiometry under impervious surfaces in China" [Paper # essd-2023-218]. We have revised the manuscript accordingly and addressed your comments point by point.

Best regards,

Qian Ding, Hua Shao, Chi Zhang, Xia Fang

**'Report #1 on essd-2023-218', Anonymous Referee #1**

**General comments:** The authors have addressed most of my concerns. I only have few comments need to be considered before it can be published.

**Response:** Thanks for your comments. We have revised the manuscript accordingly and addressed your comments point by point.

**Comment 1:** Table 1, delete the vertical lines; for the data of Beijing, delete repeated data of this study; please also include the information of ISA type.

**Response:** As recommended by the reviewer, we have deleted the vertical lines and the repeated data of this study of Beijing in the revised Table 1 (see below). However, it is difficult to add information of ISA type for each city, because Table 1 shows the city-averaged soil N density/content of multiple samples from various ISA types (to prevent confusion, we revised the related descriptions from "N density/content" to "Mean observed N density/content in the city" in the revised Table 1). It is not very meaningful to list all the sampled ISA types in each city. Instead, we added the information of background land-use type where the cities locate. (Line 99–Line 100 in the latest revised manuscript). As mentioned in Line 108, detailed descriptions of the ISA type for each sample stie can be found in our online dataset (Ding et al., 2023).

**Table 1: Compilation of soil $N_{ISA}$ studies**

| City, country | Previous studies | | | | This study | | | Background land-use type |
|---|---|---|---|---|---|---|---|---|
| | Mean observed N density in the city (kg $m^{-2}$) | Mean observed N content in the city (g $kg^{-1}$) | Depth (cm) | References | Mean observed N density in the city (kg $m^{-2}$) | Mean observed N content in the city (g $kg^{-1}$) | Depth (cm) | |
| Beijing, China | NA | 0.61 | 0–10 | (Zhao et al., 2012) | 0.08±0.02 | 0.34±0.06 | 0–20 | Cropland and deciduous orchards |
| | NA | 0.54 | 10–20 | | | | | |
| | NA | 0.42 | 20–30 | | 0.09±0.02 | 0.4±0.11 | 20–40 | |
| | NA | 0.26 | 30–40 | | 0.09±0.02 | 0.4±0.11 | 20–40 | |
| | NA | 0.37 | 0–15 | (Hu et al., 2018) | 0.08±0.02 | 0.34±0.06 | 0–20 | |
| Nanjing, China | NA | 0.49 | 0–20 | (Wei et al., 2014b) | 0.38±0.05 | 0.13±0.15 | 0–20 | |
| Yixing, China | 0.25 | NA | 0–20 | (Wei et al., 2014a) | 0.15±0.01 | NA | 0–20 | NA |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| New York, USA | 0.014 | NA | 0–15 | (Raciti et al., 2012) | 0.10±0.06 | NA | 0–15 | NA |
| Lancaster, UK | NA | 2.08 | 0–10 | (Pereira et al., 2021) | 0.07±0.04 | NA | 0–10 | NA |
| Greater Manchester, UK | 0.081 | NA | 0–10 | (O'riordan et al., 2021) | 0.07±0.04 | NA | 0–10 | NA |
| Toruń, Poland | 0.027 | 0.17 | 15–25 or 10–20 | (Piotrowska-Długosz and Charzyński, 2015) | 0.12±0.08 | NA | 0–20 | NA |

*±1SD

## References


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Hu, Y., Dou, X., Li, J., and Li, F.: Impervious Surfaces Alter Soil Bacterial Communities in Urban Areas: A Case Study in Beijing, China, Frontiers in Microbiology, 9, https://doi.org/10.3389/fmicb.2018.00226, 2018.

Wei, Z., Wu, S., Zhou, S., Li, J., and Zhao, Q.: Soil Organic Carbon Transformation and Related Properties in Urban Soil Under Impervious Surfaces, Pedosphere, 24, 56-64, https://doi.org/10.1016/s1002-0160(13)60080-6, 2014b.

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Pereira, M. C., O'Riordan, R., and Stevens, C.: Urban soil microbial community and microbial-related carbon storage are severely limited by sealing, J. Soils Sediments, 21, 1455-1465, https://doi.org/10.1007/s11368-021-02881-7, 2021.

O'Riordan, R., Davies, J., Stevens, C., and Quinton, J. N.: The effects of sealing on urban soil carbon and nutrients, SOIL, 7, 661-675, https://doi.org/10.5194/soil-7-661-2021, 2021.

Piotrowska-Długosz, A. and Charzyński, P.: The impact of the soil sealing degree on microbial biomass, enzymatic activity, and physicochemical properties in the Ekranic Technosols of Toruń (Poland), J. Soils Sediments, 15, 47-59, https://doi.org/10.1007/s11368-014-0963-8, 2015.

Ding, Q., Shao, H., Zhang, C., and Fang, X.: Observations of soil nitrogen and soil organic carbon to soil nitrogen stoichiometry under the impervious surfaces areas (ISA) of China, National Cryosphere Desert Data Center, https://doi.org/10.12072/ncdc.socn.db2851.2023, 2023.


**Comment 2:** L146, what do you mean black C?

**Response:** We explained the term black C in Line 153–Line 155: Black C is “soot or

carbonaceous products formed during the incomplete combustion of biomass and fossil fuels" (He and Zhang, 2009; Zhu et al., 2019). It can be a significant component of some urban soils (e.g., He and Zhang, 2009).

References

He, Y. and Zhang, G. L.: Historical record of black carbon in urban soils and its environmental implications, Environmental Pollution, 157, 2684-2688, https://doi.org/10.1016/j.envpol.2009.05.019, 2009.

Zhu, M., Li, M., Wei, S., Song, J., Hu, J., Jia, W., and Peng, P. a.: Evaluation of a dichromate oxidation method for the isolation and quantification of black carbon in ancient geological samples, Organic Geochemistry, 133, 20-31, https://doi.org/10.1016/j.orggeochem.2019.03.009, 2019.

**Comment 3:** L172, change Figure 7 to Figure 1.

**Response:** The reference to Figure 7 in Line 172 is removed to prevent confusion.

**Comment 4:** L181-190, these sentences can be moved to Introduction.

**Response:** We have moved these sentences to Introduction (Line 60–Line 68 in the latest revised manuscript).

**Comment 5:** L197-201, Figure 2?

**Response:** Sorry for the mistakes. The errors were corrected in Line 197–Line 201:

Gridded datasets of environmental factors, including mean annual temperature (Figure 2a), annual precipitation (Figure 2b), and elevation (Figure 2d) at 1 km resolution, were obtained from the Data Center for Resource and Environmental Sciences, Chinese Academy of Sciences (http://www.resdc.cn/). The national NPP (1985–2015) estimates at 1 km resolution was obtained from the Digital Journal of Global Change Data Repository (https://www.geodoi.ac.cn/) (Figure 2c).

**Comment 6:** L204, please confirm the data are normal distributed and linear correlated, then the Pearson's correlation can be applied. Otherwise, Spearman's correlation should be used.

**Response:** Thank you for the reminder. We have examined the data distribution. If the variables were normal distributed and linear correlated, then the Pearson's correlation were applied. Otherwise, Spearman's correlation were used in the revised manuscript. Our analysis showed that only the Latitude, temperature, NPP, and C:$N_{ISA}$ were non-normally distributed, so we used Spearman's correlation to analysis their correlationships with $N_{ISA}$. (Line 205–Line 206 and Line 278–Line 280 in the latest revised manuscript)

**Comment 7:** Figures 3 and 4 can be merged together.

**Response:** We have merged Figures 3 and Figure 4 (see below). (Line 222–Line 227 in the latest revised manuscript)

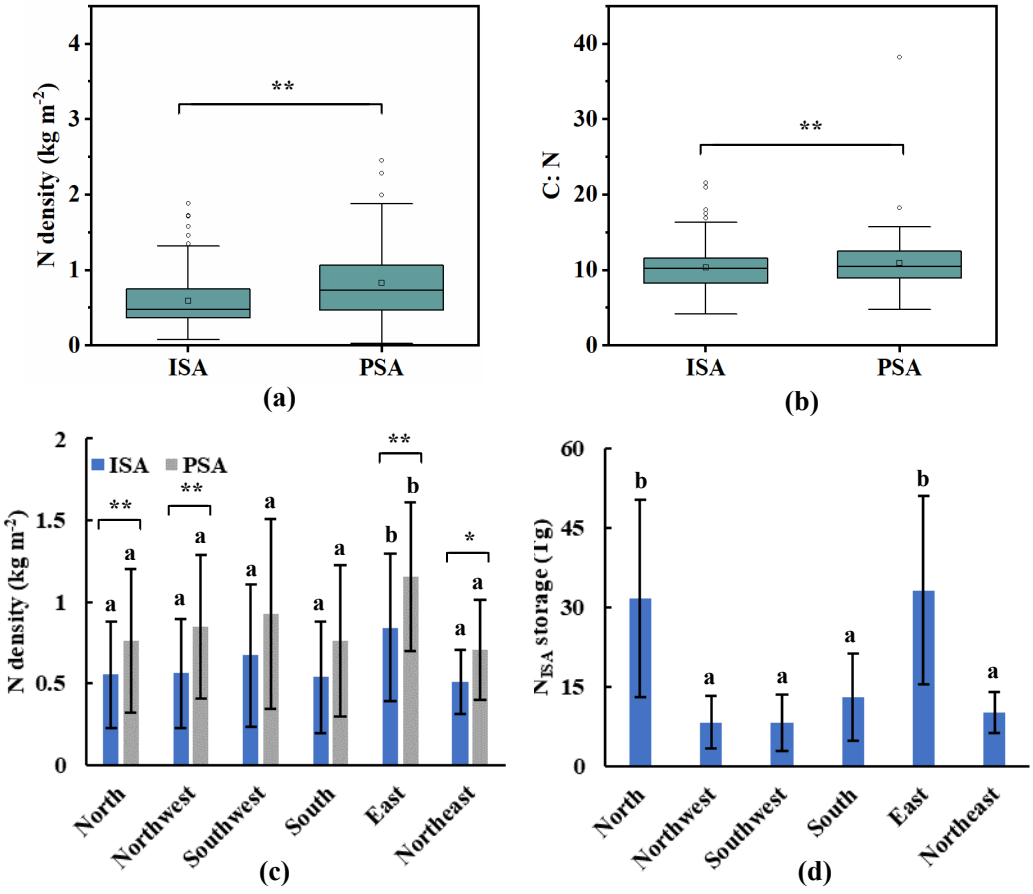


**Figure 3: The N density, N storage and C:N ratio of the ISA in China. The soil N density and**

**C:N in the ISA and the reference PSA are compared in (a) and (b), respectively. The square box shows median and quad values, the inner small rectangle is the mean value. The regional mean $N_{ISA}$ density and $N_{PSA}$ density in different subregions are compared in (c). The regional $N_{ISA}$ storage of different subregions are compared in (d). The letters indicate the significance of the difference among the subregions. * and ** indicate significant differences between ISA and PSA, $p<0.05$ and $p<0.01$, respectively.**

**Comment 8:** Figure 6, the authors should clarify the meaning of the figure, and how to achieve the simulation lines.

**Response:** We have provided detailed explanation of the trend analysis charts in the revised caption of Figure 6 (Line 256–Line 266 in the latest revised manuscript)

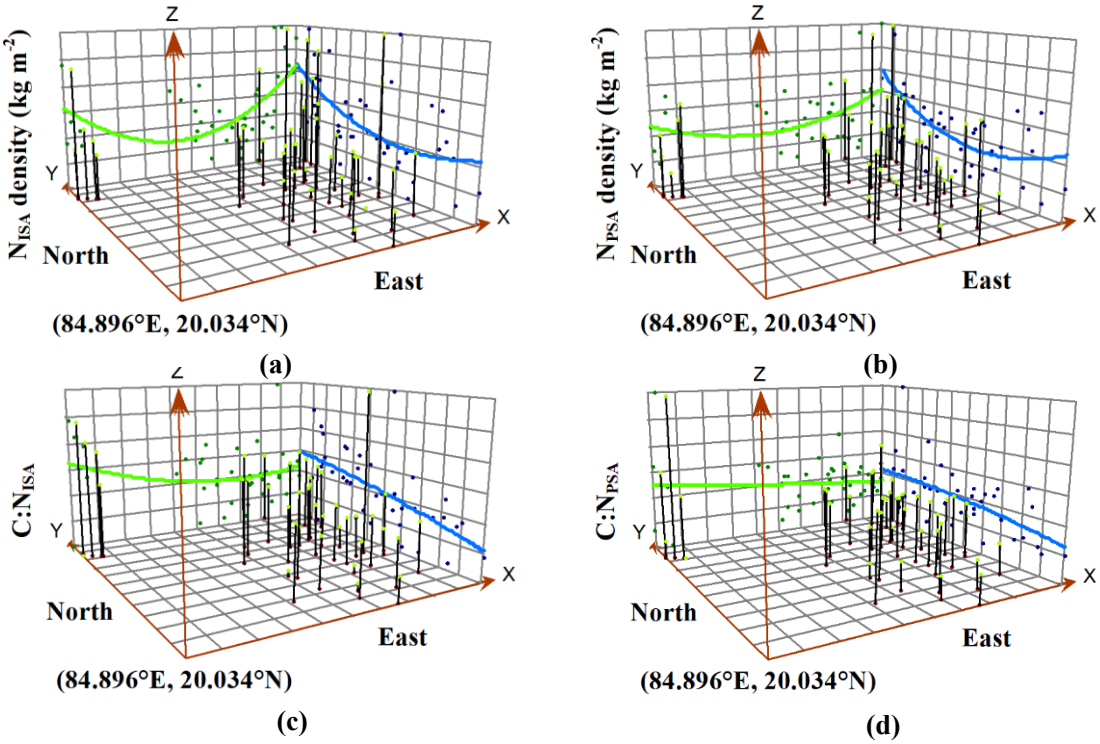


**Figure 5: Trend analysis on the variations of the city-level mean (a) $N_{ISA}$ density, (b) $N_{PSA}$ density, (c) C:$N_{ISA}$ and (d) C:$N_{PSA}$, in the east–west direction (the green trend line) and the north-south direction (the blue trend line) across China. The locations of sampled cities are plotted on the x, y plane. The x-axis indicates the east-west direction; the y-axis indicates the north-south direction. Above each sampled city, its city-averaged value of observed soil N property (i.e., $N_{ISA}$ density or $N_{PSA}$ density or C:N ratio) is given by the height of a stick in the z-dimension. The values are projected onto the x, z plane (i.e., the left vertical plane) and the**

**y, z plane (i.e., the right vertical plane) as scatterplots. This can be thought of as sideways views through the three-dimensional data. Second-order polynomials are fit through the scatterplots on the projected planes. The green line in the x, z plane shows the trend of value variation in the east-west direction, while the blue line in the y, z plane shows the trend of value variation in the north-south direction.**

**Comment 9:** L265, the sentence need to be revised.

**Response:** The sentence was revised to:

where $N_{ISA}\%_d$ is the percentage of the N stock (to 100 cm depth in total) located in the top *d* (cm) depth of the soil. (Line 273–Line 274 in the latest revised manuscript)

**Comment 10:** Table 2, modify the format; person km-2; person 10-4 yuan.

**Response:** Thanks for the suggestion. We have modified the format. We also made additional modifications to improve the art quality of the Table. (Line 290–Line 292 in the latest revised manuscript)

**Table 2: Correlations between $N_{ISA}$, C:$N_{ISA}$ and potential environmental drivers**

| Factors | N density (kg $m^{-2}$) | | C:$N_{ISA}$ | |
|---|---|---|---|---|
| | Correlation Coefficient | Sig. (2 tailed) | Correlation Coefficient | Sig. (2 tailed) |
| Longitude | 0.196 | 0.22 | –0.186 | 0.24 |
| Latitude | 0.275 | 0.08 | 0.513** | 0.00 |
| DEM (m) | 0.141 | 0.38 | 0.477** | 0.00 |
| Annual precipitation (mm) | –0.268 | 0.09 | –0.620** | 0.00 |
| Mean Temperature (℃) | –0.486** | 0.00 | –0.561** | 0.00 |
| NPP (g $m^{-2}$) | –0.106 | 0.51 | –0.516** | 0.00 |
| ISA coverage in built-up area (%) | –0.126 | 0.43 | –0.171 | 0.29 |
| Built-up area ($km^2$) | –0.072 | 0.65 | 0.062 | 0.70 |
| Greenspace coverage in built-up area (%) | –0.229 | 0.15 | –0.063 | 0.69 |
| Population density (person $km^{-2}$) | –0.032 | 0.84 | –0.072 | 0.66 |
| Per capita GDP (person $10^{-4}$ yuan) | –0.012 | 0.94 | –0.145 | 0.37 |
| City GDP (billion yuan) | –0.015 | 0.93 | –0.200 | 0.21 |

| | | | | |
|---|---|---|---|---|
| Per capita greenspace ($m^2$) | 0.098 | 0.54 | 0.044 | 0.79 |
| The fraction of the newly expanded ISA since 2002 (%) | –0.340* | 0.03 | –0.197 | 0.22 |
| $N_{PSA}$ density (kg $m^{-2}$) | 0.715** | 0.00 | NA | NA |
| C:$N_{PSA}$ | NA | NA | 0.515** | 0.00 |
| BD | –0.104 | 0.52 | NA | NA |

*$p < 0.05$;
**$p < 0.01$.