Hyperspectral inversion of heavy metal content in urban stream sediments

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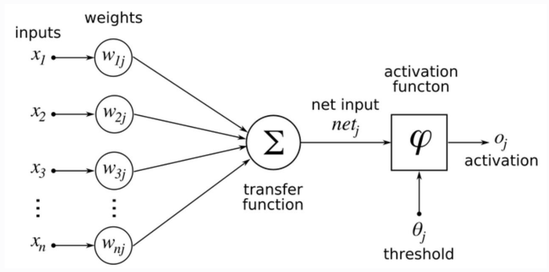
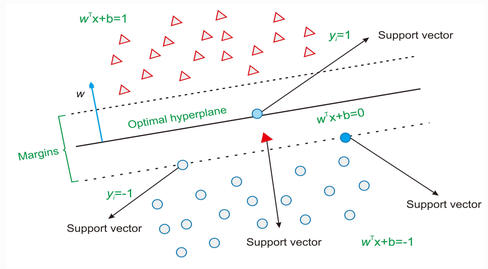
1.Background and motivation

The urban water system is called the blood vessel of the city, and the sediment of the water system records the important information of the urban environment change. In the process of urban development in Tianshui City, the discharge of industrial, agricultural and domestic sewage increased, which aggravated the problem of heavy metal enrichment in the sediment of urban water system. As the source of irrigation water, the source of urban drinking water and the river of urban landscape, the Ji River plays an important role in the development of the Tianshui region. Therefore, it is of great significance to understand the distribution information of heavy metals in Jihe river basin comprehensively and accurately.

2.Theoretical method

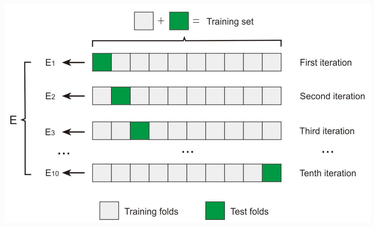
- Inversion model：Artificial eural network, ANN；Support vector machine, SVM；Stepwise multiple linear regression，SMLR





- Model cross-validation：

K-fold cross verification method



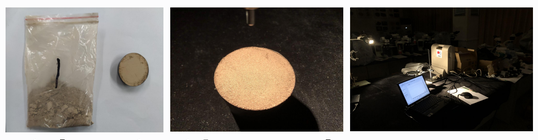
- Accuracy verification：Determination coefficients, R^2；Root mean squared error，RMSE

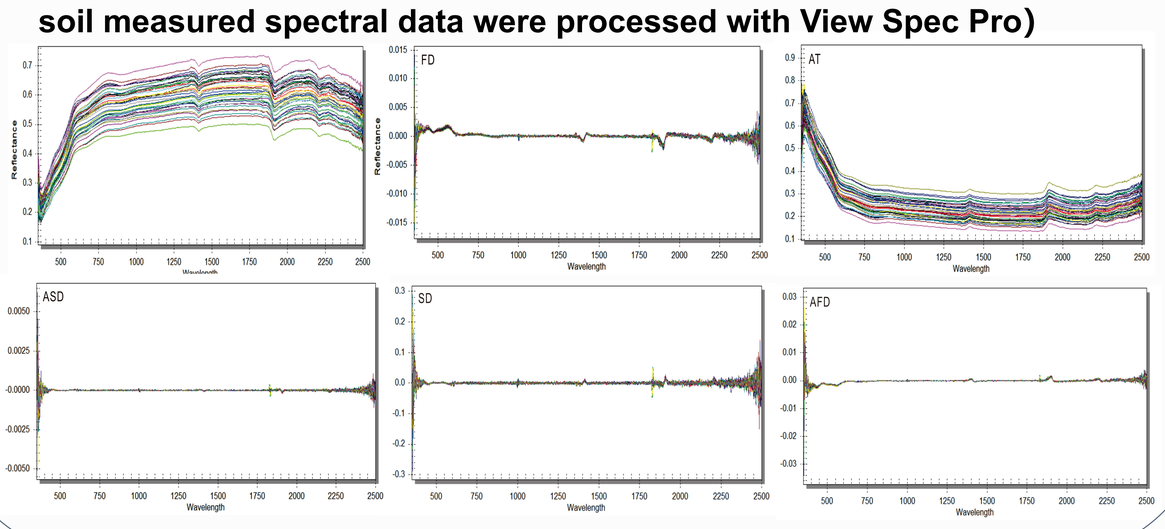
$$R^2 = 1 - \sum_{i=1}^{n}(\hat{y}_i - y_i)^2 \Big/ \sum_{i=1}^{n}(y_i - \bar{y})^2$$

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}$$

3. Experimental determination

- STEP 1: Sample collection
- STEP 2: Sample pretreatment
- STEP 3: Determination of heavy metal content in samples
- STEP 4: Sample reflection spectrum acquisition
- STEP 5: Spectral data preprocessing (The FD, SD, AT, AFD and ASD of soil measured spectral data were processed with View Spec Pro)





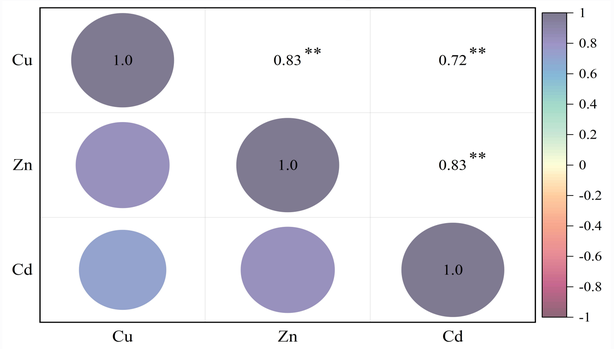
4.Experimental results and analysis

Element	Sample number	Maximum (10^{-6})	Minimum (10^{-6})	Mean (10^{-6})	Standard deviation	CV
Cu	40	67.500	29.500	45.393	9.272	20.426%
Zn	40	150.000	74.000	110.900	21.872	19.722%
Cd	40	0.420	0.140	0.259	0.065	24.927%

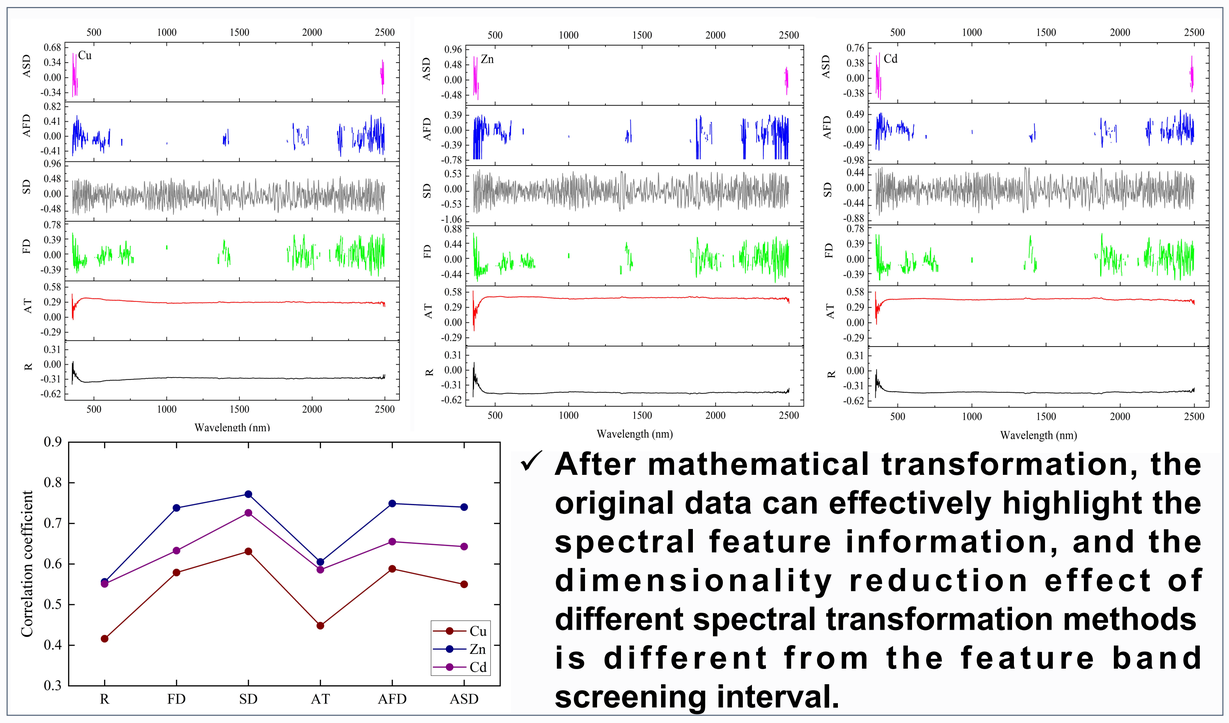
✓ Statistical analysis of the measured content of heavy metals in sediments of the study area

✓ Correlation analysis of heavy metal elements

At 0.01 confidence level, there was a significant positive correlation between Cu, Zn and Cd, indicating that the three heavy metal elements may have the same or similar pollution sources.

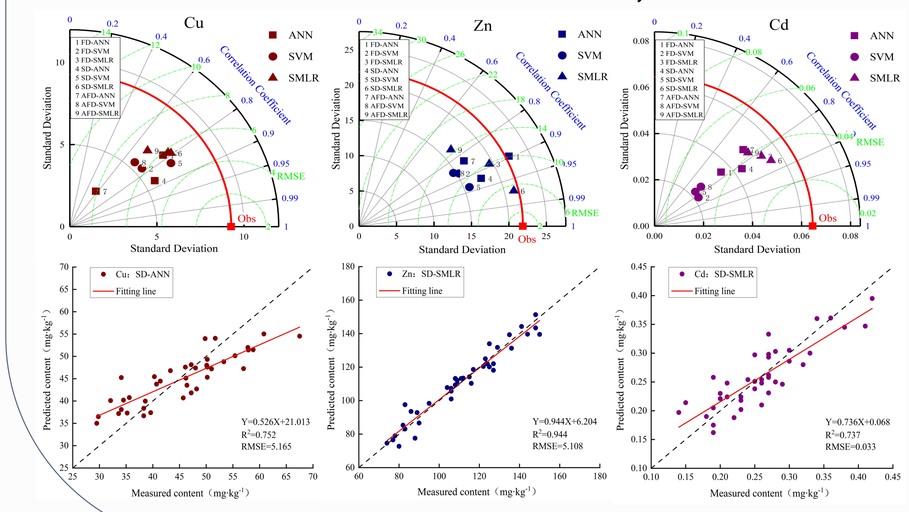


(Note: **. At 0.01 level (two-tailed), the correlation was significant; *. At level 0.05 (two-tailed), the correlation was significant.)



✓ After mathematical transformation, the original data can effectively highlight the spectral feature information, and the dimensionality reduction effect of different spectral transformation methods is different from the feature band screening interval.

✓ Optimal feature band screening: Finally, it is determined that the independent variable of the heavy metal content inversion model is the characteristic band selected after FD, SD and AFD transformation.



Model building and accuracy checking

The measured and predicted values are fitted to the scatter plot

5. Conclusion

The results show that the three models can effectively realize the inversion of heavy metal content in sediments, and under different transformation processing methods, the optimal prediction effect can be achieved by selecting appropriate models for different elements. The research results provide technical support for rapid, high-efficiency, non-destructive monitoring of urban environment and sustainable development of ecological environment.

6. Future work

- The applicability of the inversion model for different elements should be considered in the follow-up research;
- The accuracy of prediction results of the model in other stream sediment types needs to be further discussed;
- "From the point to the surface" for the next step of work research.

7. Acknowledgement

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