

## THE YELLOW RIVER-BED EVOLUTION A Statistical Proof of the Mountain-River-Desert Conjecture

by

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*When the Yellow River flows through the Hetao Plain in Inner Mongolia, north China, it forms a mountain-river-desert system with the Yin Mountains on one side and the Hobq desert on the other side. In this mountain-river-desert system, a dense growth of green grass is formed in the area fronting the river and with the mountains at the back, however, on the opposite the river, the area has an inherent trend to lost moisture, which might cause desertification. This study verifies this theoretical conjecture by analyzing the Yellow River-bed change from 2014 to 2021. The seven year change showed the river is the inherent boundary between the grassland and the dessert, and it was nothing to do with the river banks' past earth surfaces.*

**Key words:** *Yellow River-bed evolution, Mountain-river-desert relationship, satellite image, fengshui, dragon vein*

### Introduction

Everyone might think that there would be a river, there would be a grassland, but recently scientists were in great shock! The opposite might be also right, the river might be a main factor affecting the desertification process. Mei *et al.* [1] found the missing piece of the puzzle for the land's desertification, and it has changed everything you ever thought for the desert. Mei *et al.* [1] proposed a mountain-river-desert conjecture, that is a green grass is formed in the area fronting the river and with the mountains at the back, however, on the opposite the river, the area has an inherent trend to be desertified. This discovery has opened the path for a new way to reverse the desert in future.

The desertification process is to lost moisture from both air and land, and the lost moisture is taken away by the moving air, so the wind speed is the main factor in the mountain-river-desert system. According to the aerodynamics, the mountains are formed as the boundary of our studied system, where the air velocity is zero, and the area near to the boundary has less air velocity, while far away from the boundary, the air velocity is much higher, so the moisture in air and that evaporating from land are easier to be lost. Additionally the moisture will also be diffused through the river from a river bank to its opposite bank near the mountain boundary, see theoretical analysis in [1].

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When the Yellow River flows through the Hetao Plain in Inner Mongolia, north China, it forms a mountain-river-desert system with the Yin Mountains on one side and the Hobq desert on the other side. The earth's surface morphology on the both banks of the river is totally different, the area between the river and the mountains is covered with grassland, while the opposite the river, it becomes a desert, no matter how the river bed is changed. This paper is to verify this conjecture by analysis of the river-bed change and the earth surface on the river both banks.

## Research methods

### Study area

The research area is located on  $37^{\circ}35' \sim 41^{\circ}50'N$  and  $106^{\circ}10' \sim 112^{\circ}50'E$ , as illustrated in fig. 1, where the Yin Mountains, the Hetao Plain, the Yellow River and the Hobq Desert are included. This is a typical mountain-river-desert system. According to the old classic of Fengshui theory, the area fronting a river and with a hill at the back is a perfect treasure, and it is still widely practiced in China architecture design, but another factor was rarely known, that is the opposite of the river, there is a trend to lost moisture [1]. To verify this fact, we choose this research area to see the effect of river banks on desertization of an original grassland and the greening process of an original desert area.

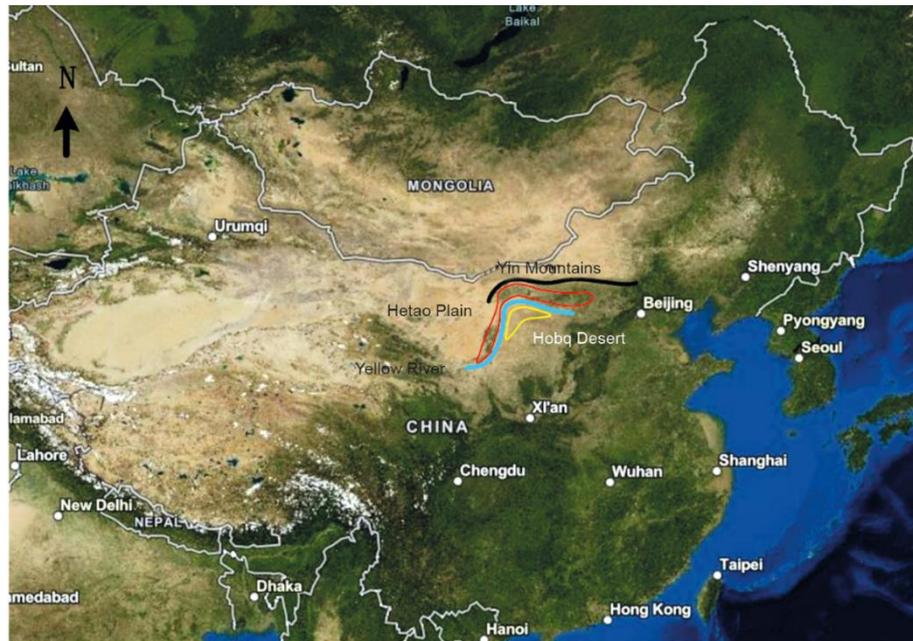


Figure 1. The mountain-river-desert system in north China

### Data sources

In this study, the multispectral remote sensing images of Landsat 8 (2014, 2021) were selected as the data source (<https://www.gscloud.cn/>). The image data covered a rectangular land area between  $107^{\circ} \sim 108^{\circ}E$  and  $45^{\circ}N$  with a spatial resolution of 30 m. The image of the course boundary of the Yellow River was observed from July and August for easy identi-

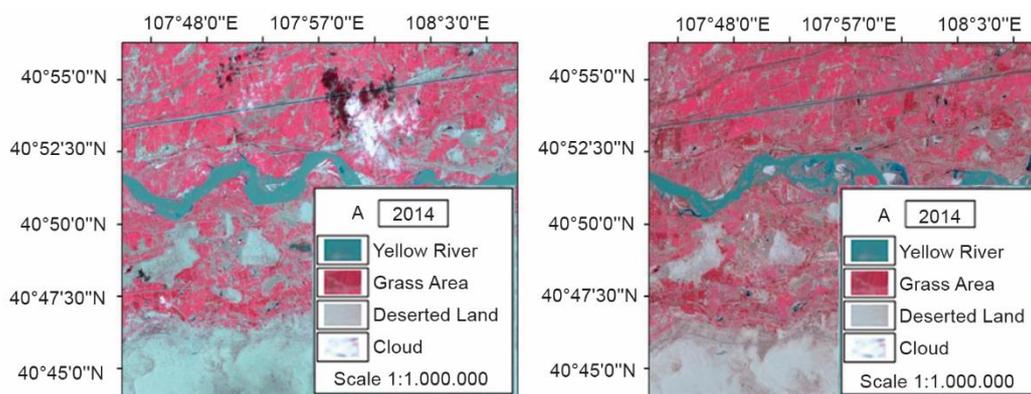
fyng the main river bed, grass area and desertified land. In addition, the data were chosen according to uniform color, moderate contrast, and part cloud (about 10%), which ensured the accuracy of the research results.

### Data processing methods

The experiment used ENVI and ArcGIS to process the image data to extract the Yellow River-bed area, and to compare the 2014 satellite data with those in 2021 to enhance the color tone. Furthermore overlaying, editing and vector comparing were carried out to analyze river channel layers of different years. In this way, the plane shape of the Yellow River-bed and its evolution history in different periods were obtained.

### Results and discussion

In this study, the image data of a section of the Yellow River-bed in the Hetao Plain were processed and analyzed, and it was found that the Yellow River-bed changed greatly, see fig. 2. It was observed that the curvature of the Yellow River-bed in 2021 is lower than that in 2014, and the Yellow River-bed has undergone significant evolution in seven years.

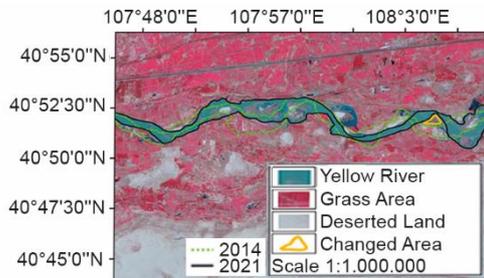


**Figure 2. River-bed change of Yellow River in the Hetao Plain from 2014 to 2021 (the data were obtained from Yellow River Conservancy Commission of the Ministry of Water Resources, [www.yrcc.gov.cn](http://www.yrcc.gov.cn))**

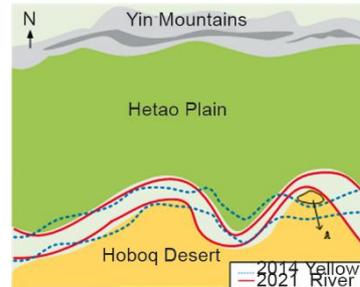
After data processing, the satellite images of the Yellow River-bed in 2014 and 2021 were superimposed and edited, and it was found that the Yellow River-bed has undergone significant northward migration, as shown in figs. 3 and 4. On the whole, the Yellow River in this area of the Hetao Plain has grass area on the north bank and a desertified land on the south bank of the Yellow River. With the evolution of the Yellow River channel in 7 years, it was found a changed area, as shown in the yellow circle in fig. 3. This area can be used for analyzing the mountain-river-desert system, it was a green area in 2014, see the area A in fig. 4, because it located between the river and the mountains. However, it became a desertified land in 2021, because it became the opposite bank of the river, this gives a clear verification of the mountain-river-desert conjecture, which was proposed in [1].

### Fengshui

Fengshui [2, 3] is the oldest nature science, which was originally to study the relationship among Feng (wind), Shui (water), and human, and was used to solicit a good site of habitation [4] in ancient China, and it is still applied in modern architecture [5-12].



**Figure 3. The river-bed change (the green discontinuous line: 2014, and the black solid line: 2021)**



**Figure 4. The mountain-river-desert relation; the area A was a grassland in 2014 and it became a desert area in 2021 due to the change of the river bed**

According to an old classic *Burial Classic* written by Guo Pu (276-324), qi should be gathered so that it is not scattered, it should be in motion so that it will be held. The so-called Fengshui is, first, to possess water and secondly to harbor wind, the Classic is too elusive to be fully understood, and requires explanation in details.

What is qi? Guo Pu says: qi of yin and yang becomes wind when blowing; and it turns out to be clouds when arising. In a modern view, yang qi is air, and yin qi is the moisture involved in air. So Guo Pu's saying can be explained as yin qi (the moisture in air) is important and should save it as you save money in a bank, however, similar to the money in the bank, qi is not vital when it is still. To be vital qi, it should be in motion as said in the Classic. "It is the earth surface's potential that makes qi move", Guo Pu explains. What is the earth surface's potential? Mei, et al. [1] claimed it is exactly the Bernoulli potential ( $B$ ):

$$B = \frac{1}{2}u^2 + \frac{P}{\rho} \quad (1)$$

where  $u$  is the air speed,  $P$  – the air pressure, and  $\rho$  – the air density.

According to eq. (1), yin qi (the moisture in air) will move from a higher earth surface's potential to a lower one, the permeability speed can be calculated:

$$w = k \frac{B_{\text{high}} - B_{\text{low}}}{L} \quad (2)$$

where  $w$  is the velocity,  $k$  – permeability coefficient,  $B_{\text{high}} - B_{\text{low}}$  is the potential difference of two places, and  $L$  is their distance. According to the mountain-river-desert relation discussed in [1], Hetao plain in fig. 4 can save yin qi (moisture) through moving air (wind) and moving river (water), see detailed explanation in [1]. In fig. 4, the moving river has the highest potential, while the bottom of the mountain vein (dragon vein) has the lowest potential.

## Conclusions

A river or a canal might be a two-edged sword for its local ecological environment. Before making a conclusion for this paper, we would like to introduce a famous idiom story about orange trees, their fruits are quite different on south and north Huaihe River. The story was recorded in Yanzi' s Spring and Autumn Annals written by Yan Ying (?~500 BC), which records many historical events happened in Spring and Autumn Period (770 BC~476 BC).

This old story also explained the important effect of a river on its local environment. There were also many canals for the organization of irrigation, but a canal might have a negative effect on the irrigation system depending upon its near hills or buildings.

In this study, the analysis of image data has confirmed that the change of the Yellow River-bed has an impact on the local ecological environment on both sides of the Yellow River. According to the mountain-river-desert relation, the area between the mountains and a river has not a chance to become a desert, and the river's opposite area has an inherent trend to lost moisture, which might cause desertification. This study has further verified this conjecture by analyzing the obviously changed Yellow River-bed in the Hetao Plain from 2014 to 2021, and found the changed area caused by the channel change. In the mountain-river-desert system, the Yellow River in the studied area is always the boundary between green land and the desert, as shown in fig. 4.

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### Reference

- [1] Mei, Y., et al., On the Mountain-River-Desert Relation, *Thermal Science*, 25 (2021), 6B, pp. 4817-4822
- [2] Paton, M. J., Science and Fengshui The Concept shi, Rationality and Emotion, and the Ritualisation of Knowledge, *Science and Education*, 30 (2021), 6, pp. 1371-1386
- [3] Jin, Z. K, Juan, Y. K., Is Fengshui a Science or Superstition? A New Approach Combining the Physiological and Psychological Measurement of Indoor Environments, *Building and Environment*, 201 (2021), Aug., 107992
- [4] Xu, Y. Q., et al., Spatial Distribution and Site Selection Adaptation Mechanism of Traditional Villages Along the Yellow River in Shanxi and Shaanxi, *River Research and Applications*, On-line first, <https://doi.org/10.1002/rra.3977>, 2022
- [5] Mak, M. Y., Ng, S. T., The Art and Science of Feng Shui – A Study On Architects' Perception, *Building and Environment*, 40 (2005), 3, pp. 427-434
- [6] Jeffreys, P., Feng Shui for the Health Sector: Harmonious Buildings, Healthier People, *Complementary Therapies in Nursing & Midwifery*, 6 (2000), 2, pp. 61-65
- [7] Li, X. M., et al., Hidden from the Wind and Enjoying the Water : The Traditional Cosmology of Fengshui and the Shaping of Dong Villages in Southwestern China, *Landscape Research*, 44 (2019), 5, pp. 614-627
- [8] Tam, C. M., et al., Feng Shui and Its Impacts on Land and Property Developments, *Journal of Urban Planning and Development*, 125 (1999), 4, pp. 152-163
- [9] Ogilvie, M., et al., Using Traditional Rituals in Hospitality to Gain Value: A Study on the Impact of Feng Shui, *International Journal of Hospitality Management*, 72 (2018), Jun., pp. 1-9
- [10] Coggins, C., Minor, J., Fengshui Forests as a Socio-Natural Reservoir in the Face of Climate Change and Environmental Transformation, *Asia Pacific Perspectives*, 15 (2018), 2, pp. 4-29
- [11] Ma, J., et al., Optimal Design of Passive Solar Building, *Thermal Science*, 26 (2022), 3B, pp. 2453-2458
- [12] Xu, Y. Q., et al., Spatial Distribution and Site Selection Adaptation Mechanism of Traditional Villages along the Yellow River in Shanxi and Shaanxi, *River Research and Applications*, On-line first, <https://doi.org/10.1002/rra.3977>, 2022