

WATER SCARCITIES, CLIMATE CHANGE, AND URBAN REACTIONS: A STUDY BASED ON THE LEADING RIVER IN CHINA

1st ZHOU MINGWU, 2nd Aiman Al-Odaini

ABSTRACT

All three of China's major rivers—the Yangtze, the Yellow, and the Mekong—are vital to the country's economy and way of life. There is a strong network of connections between these three rivers. Without these waterways, none of these businesses would be able to stay in business. River systems and those who rely on them are under tremendous pressure from many directions. Two of these problems are water scarcity and climate change. These river systems are already struggling to keep up with the rising demand. Water scarcity, climate change, and adaptive responses in Chinese urban contexts are examined via the lens of China's main river basins in this research. This method allows us to investigate all of the potential sources of water shortage. Numerous factors are impacting the water supply, as seen in this research. Some of these changes include more frequent and severe droughts, altered patterns of precipitation, and generally higher average temperatures. Ecosystems and civilisations are already under a great deal of stress due to climate change. Creative solutions to the issue of water shortage have been driven in many locations by the increased demand for water due to urbanisation. As a result of the data being made public, communities are implementing methods for managing water resources more effectively, recycling more wastewater, and improving water use in farming and manufacturing. It is the duty of the local government to implement the policies stated here. This is just one of several accessible possibilities at the moment; there are many more besides. The purpose of this study is to provide fresh information to the ongoing discussions. Whatever their perspective may be, the findings demonstrate that the destiny of China's rivers is an issue with consequences on a local, national, and even international scale. This holds true regardless of one's perspective.

Keywords: Severe Droughts, Communities, Water Scarcity, Climate Change, River Systems.

1. INTRODUCTION

The Yangtze, Yellow, and Mekong rivers all contributed significantly to China's economic, cultural, and social growth. Here may find a few of China's most important rivers. Farming, industry, power production, and urban populations all rely on water from these rivers, thus they're important for the nation's prosperity and security. This is because their climate change capabilities might be over utilised. A growing number of river systems are under risk from rising sea levels and other concerns related to water constraint. Over the past few decades, this danger has been becoming worse and worse. This risk is there due to the interaction between these two variables. There is less water available because of climate change, different patterns of rainfall, and frequent droughts. Several factors contributed to this occurrence. Since floods are becoming more often and glaciers are melting, people are understandably worried about hydrological conditions. Now it's much worse because of this. Fast industrialisation and urbanisation have given rise to a significantly more serious problem than the one that previously existed. The high water demand from infrastructure, businesses, and residential areas in fast-growing cities is the main cause of this. Water contamination and environmental degradation have emerged as a consequence of resource inequality between upstream and downstream regions, as well as between urban and rural areas, as a result of rising competition for limited resources. All of these unsavoury outcomes have transpired because there just isn't

enough of everything. Proclaim that these undesirable results are mostly caused by the increasing competition for limited resources. China has emerged as a key figure in discussions around climate resiliency, water security, and sustainable development. This can be due to the problems discussed above (Ban et al., 2025). In these conversations, several nations are taking part. Many American cities have already begun to use adaptive strategies. In order to build "sponge city" programs that can handle climate change, people have used integrated water resource management and wastewater recycling. Also, preparations to start have been completed. The socioeconomic level of the area, the availability of funds, and the laws controlling the programs' operation are some of the variables that determine how effectively they perform. This issue persists despite efforts at the national and regional levels to encourage conservation, efficiency, and innovative technology. This statement is correct regardless of the outcome of the implementation of these limitations. Possible topics covered in this study include the effects of water shortages, climate change, and urban adaption strategies on China's main rivers (Chen et al., 2020).

2. BACKGROUND OF THE STUDY

China is now facing one of its worst issues ever: a lack of water. This lack of resources can have a big impact on the country's future in terms of the economy, society, and the environment. The Yangtze, Yellow, and Hai rivers are some of the most essential in the country. They provide water to the cities, farms, and factories. These are some of the most important rivers in the country. These rivers not only move water, but they also provide most of the country potable water. Urbanisation, industrialisation, and climate change, on the other hand, have made the seasons less predictable and the rivers less full (Li et al., 2024). All of these factors have led to the current scenario. This has still happened, even if the water levels have gone down. Because of all this, these water systems have been under a lot of stress. The water situation is becoming worse as time goes on as pollution levels rise and river levels fall. The fundamental reason for this is that the levels of the rivers are falling down. Food production, energy generation, and public health are all at risk for society's well-being. It is important to study the relationship between water shortages and the health of river ecosystems, but it is also important to come up with solutions that suit human needs while protecting natural environments. It is really important to think about how important this research is for river ecosystems (Gong et al., 2021).

3. PURPOSE OF THE RESEARCH

This study investigates the impact of water scarcity on river flow, water quality, and ecological equilibrium, aiming to elucidate the relationship between water shortage and the condition of China's principal rivers. The research can concentrate on the impact of these elements. The primary emphasis of the inquiry is the impact of water supply limitations on these features. Climate change, over-extraction, and pollution are three of the key reasons why there isn't enough water. This study tries to look into these issues. These dynamics affect the long-term health of big rivers like the Yangtze, Yellow, and Hai. The Yangtze, Yellow, and Hai rivers are some of the most important ones that this research might effect. Participants in the study can also be asked to judge how these pressures influence the rivers' long-term potential to support the economy. This study's main aims are to find a better balanced way to develop that takes into consideration people's needs and the health of the environment. Another key purpose is to encourage people to save water and provide them ideas on how to properly manage river basins. The investigation can facilitate an understanding of these processes, being the first step towards their acquisition.

4. LITERATURE REVIEW

China is having a harder and harder time with the problem of not having enough water. It is one of the country's most important challenges right now. The Yangtze, Yellow, and Hai rivers are having this difficulty because their water levels are dropping, their pollution levels are rising, and their seasonal flow is unpredictable. The demand for water is growing because cities are growing quickly, factories are producing more goods, and agriculture is becoming more. Another reason for this rise is that industrial output is going increasing. Climate change has changed how rain falls and caused more severe droughts, which has put additional stress on river systems (Lei et al., 2022). As a result of the changes, river ecosystems have been harmed, water supplies have been cut, and difficulties with food security and energy production have grown. Another result is that there is less water available. Because of this, China has made a number of big initiatives to fix the problem, such as making plans to manage river basins, starting projects to move water, and putting stringent regulations on how much water people may use. This is an attempt to bring everything back into balance. Everyone who has an interest in the subject is anxious about how hard it can be to fix the difference in water resources between the north and south. Cities that are growing in population need to think outside the box if they want to fix this issue. Some examples of these kinds of solutions in operation include recycling wastewater, smart irrigation, and bringing back natural systems. To make policies that safeguard natural systems while encouraging urbanisation, it is important to properly understand the evolving relationship between river quality and water deficit. This information is very important for making environmental policies. It is very important that the people who help make policy have the right skills and expertise (Liu & Zhang, 2022).

5. RESEARCH QUESTIONS

- What is the effect of water scarcity on china's main river?
- What is the effect of climate change on china's main river?

6. RESEARCH METHODOLOGY

6.1 Research Design

The SPSS version 25 to do the quantitative data analysis. The direction and intensity of the statistical association were determined using the 95% confidence interval and odds ratio. At $p < 0.05$, the researchers established a criteria that was considered statistically significant. The data's essential features were extracted using a descriptive analysis. When analysing data transformed by computing tools for statistical analysis or data collected from surveys, polls, or questionnaires, quantitative methods are often used.

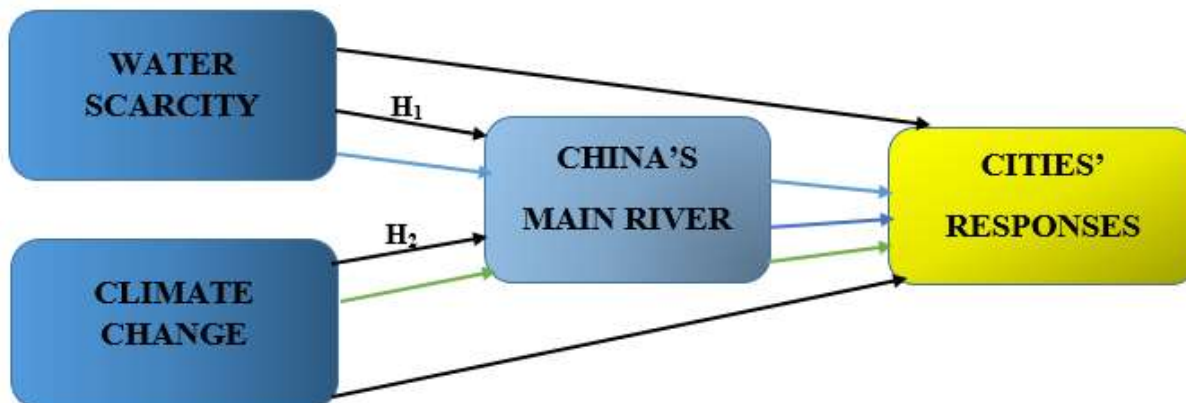
6.2 Sampling: Research participants filled out questionnaires to provide information for the research. Data collection for the study was done using questionnaires. A sample size of 1,463 was determined using the Rao-soft algorithm. Of the 1600 surveys sent out, 1557 were returned; 57 were not included because they were missing information. The study ultimately made use of 1500 questionnaires.

6.3 Data and measurement: The research relied heavily on a questionnaire survey—either a one-to-correspondence survey or a Google Form—to compile its data. The survey included two parts: (A) a section asking participants to identify themselves according to their preferred method of contact (online and offline), and (B) a section asking them to rate various variables using a 5-point Likert scale. Many other sources, most of which could be accessible online, provided the secondary data.

6.4 Statistical Software: With the help of SPSS 25 and MS-Excel, they ran the statistical analysis.

6.5 Statistical tools: A descriptive analysis was carried out to get an understanding of the underlying structure of the data. A descriptive analysis to get to the bottom of the data's essential features. ANOVA and factor analysis to check for validity.

7. CONCEPTUAL FRAMEWORK



8. RESULTS

• Factor Analysis

Factor Analysis (FA) finds widespread usage in the process of confirming the underlying component structure of a collection of measurement items. It is thought that elements that cannot be seen directly impact the scores of the variables that have been examined. Among the methods that rely on models is accuracy analysis (FA). The main focus of this research is on establishing relationships between visible events, their hidden causes, and measurement errors. The Kaiser-Meyer-Olkin (KMO) Method may be used to determine whether the data is suitable for factor analysis. Both the overall model and each individual model variable are tested for adequate sampling. By using statistical methods, may measure how much common variance there may be among several variables. Factor analysis is often more appropriate for data sets with smaller percentages.

The output of KMO is an integer between 0 and 1. If the KMO value is between 0.8 and 1, it means that the sampling was sufficient.

If the KMO is less than 0.6, it means that the sample was insufficient and corrective action is needed. May use the best judgement here; 0.5 has been used as an example by various writers, thus the range is 0.5–0.6.

The partial correlations are much larger than the overall correlations when the KMO is near to 0. To reiterate, significant correlations significantly impede component analysis.

The following are the acceptance criteria set by Kaiser:

Declining from 0.050 to 0.059.

0.60-0.69 points lower than typical

Range often seen in middle school: 0.70 to 0.79.

A quality point value ranging from 0.80 to 0.89 is required.

Astounded at the range of 0.90 to 1.00.

Table 1: KMO and Bartlett's Test

| KMO and Bartlett's Test | | |
|---|---------------------------|----------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .870 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 3252.968 |
| | df | 190 |
| | Sig. | .000 |

Applying Bartlett's Test of Sphericity provided further confirmation of the correlation matrices' overall significance. The sample adequacy value according to Kaiser-Meyer-Olkin is 0.870. A p-value of 0.00 was discovered by researchers using Bartlett's sphericity test. The correlation matrix was shown to not be a correlation matrix by a significant test result from Bartlett's sphericity test.

❖ **INDEPENDENT VARIABLE**

• **Water Scarcity**

A water shortage occurs when the available water supply is insufficient to fulfil the current demand. A water deficit is shown here. Both humans and the environment are under systemic stress as a result of this condition. Increased demand from cities and industry, climate change, irregular rainfall, and over-extraction of groundwater are some of the factors that impact it. Furthermore, it is affected by a myriad of other factors as well. A severe water shortage has a disproportionately negative effect on the people living in northern China. Water consumption per capita in southern China is much higher than in northern China. Let me explain. The water scarcity has a significant impact on river flows, agricultural output, and the accessibility of water for urban areas. In order to distribute water in a sustainable manner and make the most of limited resources, cities should use technologies such as water recycling and desalination. Stricter regulations are also necessary. The sustainability of the water supply is the reason for this action. In order to satisfy the requirements imposed by the relevant regulatory agencies, certain measures are being implemented (Tan et al., 2025).

• **Climate Change**

There can be less water available along China's main river distribution networks as a result of climate change. Because of this, the subject of this study has been chosen as the independent variable. They looked at climate change, the main outside influence, and they had it figured out. To be more precise, this is due to the fact that emissions of greenhouse gases constitute a significant portion of the issue. Alterations to river flows, changes in the frequency and severity of droughts, shifts in precipitation patterns, and variations in average global temperatures are all indicators that this is taking place. This is only a small selection of the many potential indicators. Current water shortages are becoming much more severe as a result of these climate changes, which are already straining urban water distribution and management systems. The conflict arose because of the changing weather patterns. The purpose of this research is to learn more about the relationship between weather-related scarcity and the policies, tactics, and adaptive measures that cities use to combat climate change. The operationalisation of climate change uses long-term meteorological and hydrological data to achieve this goal (Yang et al., 2022).

❖ MEDIATING VARIABLE

• China's Main River

The Yangtze, the Yellow, and the Hai are three of China's most significant rivers that help connect the two. The Yangtze is by far the most significant of these rivers. China values each of these rivers very highly. The Yangtze, Yellow, and Hai rivers are all vital to how cities deal with water shortages and the limited quantity of water that is accessible. The importance of the connection between these two parts comes from how deep their relationship is. The way cities respond to and adapt to water shortages is strongly tied to the quality and flow of the rivers. The reason for this is because these rivers provide much of the water that people drink and use for business and farming. That makes it clear that the issue exists. This is largely because these rivers are the main sources of water for many various applications. Changes in the river's health, such as lesser water flow, increased toxin levels, and seasonal changes, can lessen the bad effects of scarcity. Some of these changes include the seasons changing and more pollution. Some of these changes happen at the same time as the seasons change. The alterations have an effect on both the ecosystem's ability to bounce back and the severity of the shortages. The modifications affect both sides of the company. To accurately measure how well communities' efforts to manage water sustainably are working, they need to know a lot about the status of these rivers. This specific piece of information is crucial for the proper completion of the task, given the goal that was specified previously (Yang et al., 2024).

• Relationship between Water Scarcity and China's Main River

There is a strong link between China's most significant rivers and the country's water scarcity. The Yangtze, Yellow, and Hai rivers are the main sources of water for China's cities, farms, and industrial. This helps us understand how things are right now. This problem came arisen because rivers like this one are China's main source of water. This is where this event started. Less rain, over-extraction, or climate change might make the water shortage worse, which would make these rivers have less water, slower flows, and more pollutants. All of these factors are to blame for the lack of water. At the same time, there can be less water. This affects the rivers' capacity to support human and economic activity and their ability to regulate the natural environment in a way that is good for the environment. The rivers are impacted by things in the environment, and this is the fundamental reason why. On the other hand, the state of these rivers might either make the water shortage worse or better, depending on how effectively they are managed. They came to this conclusion because of how the rivers were. The quality of management they receive is what sets them apart. They may make things better or worse based on what they choose. Water shortage is becoming worse because of a multitude of problems, such as river systems being worse, not being able to hold water, and bad water quality. There are other things to think about, such the bad water quality. Rivers that are well-kept and in excellent form, on the other hand, may stop shortages and offer a more regular flow, making them a better supply of water. So, well-kept rivers look great. Long-term solutions to water shortages and maintaining ecological balance and water security depend on sustainable river basin management. These goals all rely on each other. This link helps to stress how crucial it is to do what was said previously (Yang et al., 2022).

In response to the above discussion, the researcher has offered the following hypothesis to examine the correlation between Water Scarcity and China's Main River.

“H₀₁: There is no significant relationship between Water Scarcity and China's Main River.”

“H₁: There is a significant relationship between Water Scarcity and China's Main River.”

Table 2: H_1 ANOVA Test

| ANOVA | | | | | |
|----------------|----------------|------|-------------|---------|------|
| Sum | | | | | |
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 39588.620 | 526 | 5355.517 | 999.909 | .000 |
| Within Groups | 492.770 | 973 | 5.356 | | |
| Total | 40081.390 | 1499 | | | |

This investigation yields remarkable results. The F value is 999.909, attaining significance with a p-value of .000, which is below the .05 alpha threshold. This signifies the “ H_1 : *There is a significant relationship between Water Scarcity and China’s Main River.*” is accepted and the null hypothesis is rejected.”

- **Relationship between Climate Change and China’s Main River**

The Yangtze, the Yellow, and the Hai are three of China's most significant rivers. The weather changes all the time, which has a big effect on these rivers. Because of this, the water supply and the health of the ecosystem are affected by the rivers flowing in diverse ways. This changes the way the river flows. As temperatures rise upstream, they speed up the melting of glaciers. This makes the river flow faster for a short time, but it lowers the water supply in the long term as the glaciers continue to retreat. This occurs in certain regions when the temperature rises. The melting glaciers are making the rivers flow faster, which is what causes this to happen. This is happening because the temperature is increasing, which is causing glaciers to melt quicker. Changes in rainfall patterns may cause seasonal differences in river systems. These kinds of imbalances may mess up river systems. The changes in river systems are usually what generate problems. In some places, droughts are happening more often, while in others, floods are happening more often. Both of these things are happening at the same time. These adjustments cause the outcomes. River ecosystems are already quite fragile, and these changes make things worse by lowering water quality, moving silt, and destroying aquatic habitats. The oscillations have a big influence on ecosystems in the water. The long-term effects of climate change are making many rivers more variable and less predictable. This has occurred because climate change is a real and present threat. This makes it very hard to prepare for and control the water supply at the same time. To make river basin management plans that accomplish these three things successfully, they need to thoroughly understand how ecological integrity, a sustainable water supply, and resilience to climate-driven challenges are all connected. These approaches are now being improved and put into use to maintain the natural system's integrity (Yu et al., 2023).

In response to the above discussion, the researcher has offered the following hypothesis to examine the correlation between Climate Change and China’s Main River.

“ H_{02} : *There is no significant relationship between Climate Change and China’s Main River.*”

“ H_2 : *There is a significant relationship between Climate Change and China’s Main River.*”

Table 3: H₂ ANOVA Test

| ANOVA | | | | | |
|----------------|----------------|------|-------------|----------|------|
| Sum | | | | | |
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 39588.620 | 536 | 5755.517 | 1074.592 | .000 |
| Within Groups | 492.770 | 963 | 5.356 | | |
| Total | 40081.390 | 1499 | | | |

This investigation yields remarkable results. The F value is 1074.592, attaining significance with a p-value of .000, which is below the .05 alpha threshold. This signifies the “*H₂: There is a significant relationship between Climate Change and China’s Main River.*” is accepted and the null hypothesis is rejected.”

9. DISCUSSION

Cities in big river basins in China are facing serious problems due to unpredictable weather and increasing water demand. The exponential growth in water use over the last several decades is a key factor in this problem. The research found that the speed with which people can acquire water greatly influences their conduct. They may get a synopsis of the possible study results by following this line. A curve, rather than a straight line, could better illustrate the relationship between scarcity and urban responses. This is a better representation of the bond between the pair. The dilemma has arisen since the two things do not seem to be connected. One of the elements that affects how cities work is, without a question, scarcity. The gravity of the situation determines how quickly things need to be resolved and how much each town can do to alleviate water shortages. Depending on the severity of the problem, different types and amounts of information can be required. Taking this into account helps in clarifying the many elements that have brought about the present condition of things. Residents in regions with less secure river systems, such as the Yellow River basin, have acted more quickly and extensively than those in regions with more stable water sources. Despite much of the focus being on the Yellow River basin, the present water shortage has had a severe impact on other river basins. Lots of people are being hurt since this scarcity has spread to other river basins. A lot of places are starting to feel the effects of this now. When resources are few, the process of technological adaptation becomes even more important in this context. The increasing need for drinkable water has led to a boom in the development of sponge cities, recycling systems, and rainwater collection systems. This is mostly caused by the increasing need for water. As part of this, may also build sponge settlements. Maintain consistency; it's crucial in this respect. They need to pay close attention to this matter. At the end of the day, it's clear from the conversation that communities react differently depending on the kind, intensity, and effectiveness of the measures they adopt in response to water shortages. This emphasises the clear significance of seeing scarcity as a driving force behind new ideas and changes in legislation to enhance the readiness for the unavoidable persistence of climate change. The quest's end objective is sustainable development.

10. CONCLUSION

China's main rivers are important for keeping the country's ecological balance, in addition to helping the economy, social welfare, and the environment. It is important to acknowledge this. One of the most important things about China's rivers is that climate change and water shortage are linked. This link shows how important these rivers are. There isn't enough water available, which is causing river flows and water quality to go down. Climate change is also making

seasonal weather patterns less predictable by melting glaciers and making extreme weather events happen more often. Both of these problems are caused by climate change. Because of this, river systems that are currently under a lot of stress can become even more pressured. Right present, river systems are under a lot of stress. Taking all of these things into account creates a vicious cycle of less water and worse environmental conditions. This cycle is dangerous in places where energy is made, water is brought to cities, and food is always available. They are also bad for Mother Earth, which makes things much worse. To keep rivers in good shape in the future, they need to enhance river basin management, make better use of water, repair ecosystems that have been harmed, and add climate adaption strategies. China's main rivers need to be planned in a way that is sustainable and well-coordinated if they are going to keep providing for people now and in the future. This is the only way to make sure they can meet the needs of future generations.

REFERENCES

- Ban, Q., Tian, G., Xia, Q., Chen, Y., Zhao, Q., & Wan, X. (2025). Resilience assessment of city-level virtual water flow network in the Yellow River Basin, China. *Sustainable Cities and Society*, 106529.
- Chen, Y., Zhu, M., Lu, J., Zhou, Q., & Ma, W. (2020). Evaluation of ecological city and analysis of obstacle factors under the background of high-quality development: Taking cities in the Yellow River Basin as examples. *Ecological Indicators*, 118, 106771.
- Gong, Q., Guo, G., Li, S., & Liang, X. (2021). Decoupling of urban economic growth and water consumption in Chongqing and Chengdu from the “production-living-ecological” perspective. *Sustainable Cities and Society*, 75, 103395.
- Lei, M., Zhou, J., Zhou, Y., Sun, Y., Ji, Y., & Zeng, Y. (2022). Spatial distribution, source apportionment and health risk assessment of inorganic pollutants of surface water and groundwater in the southern margin of Junggar Basin, Xinjiang, China. *Journal of Environmental Management*, 319, 115757.
- Liu, D., & Zhang, K. (2022). Analysis of spatial differences and the influencing factors in eco-efficiency of urban agglomerations in China. *Sustainability*, 14(19), 12611.
- Li, L., Knapp, J. L., Lintern, A., Ng, G. H. C., Perdrial, J., Sullivan, P. L., & Zhi, W. (2024). River water quality shaped by land–river connectivity in a changing climate. *Nature Climate Change*, 14(3), 225-237.
- Tan, X., Liu, B., Tan, X., Huang, Z., & Fu, J. (2025). Combined impacts of climate change and human activities on blue and green water resources in a high-intensity development watershed. *Hydrology and Earth System Sciences*, 29(2), 427-445.
- Yang, J., Ma, X., Zhao, X., & Li, W. (2022). Spatiotemporal of the coupling relationship between ecosystem services and human well-being in Guanzhong plain urban agglomeration. *International Journal of Environmental Research and Public Health*, 19(19), 12535.
- Yang, Y., Zhang, Y., Zhu, B. X., Zhou, J., Liu, Y., Gao, D., & Sauer, J. (2024). ICT promotes smallholder farmers’ perceived self-efficacy and adaptive action to climate change: Empirical research on China's economically developed rural areas. *Climate Services*, 33, 100431.
- Yang, Y., Zhang, Y., Yang, H., & Yang, F. (2022). Horizontal ecological compensation as a tool for sustainable development of urban agglomerations: Exploration of the realization mechanism of Guanzhong Plain urban agglomeration in China. *Environmental Science & Policy*, 137, 301-313.
- Yu, H., Chen, C., & Shao, C. (2023). Spatial and temporal changes in ecosystem service driven by ecological compensation in the Xin'an River Basin, China. *Ecological Indicators*, 146, 109798.