

WATER SCARCITY, CLIMATE CHANGE, AND URBAN RESPONSES: A STUDY FOCUSED ON CHINA'S PRIMARY RIVER

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ABSTRACT

Three of China's rivers play an important role in the country's economy and culture. These waterways are the Mekong, Yangtze, and Yellow rivers. Several businesses rely on the survival of these rivers to carry out their operations. However, water scarcity and climate change are putting a heavy strain on river systems and the people who rely on them. The scarcity of water is the main reason of this. The demand is putting a pressure on these river systems, and they are starting to feel it right away. With a focus on China, this research aims to delve into the topic of water shortage, climatic unpredictability, and adaptive responses in urban settings. The study is structured on the main river basins in China. Using this method, they can fully examine the factors that cause water shortage. According to this research, the quantity of water that is accessible is changing due to a number of variables, including increasing temperatures, changing patterns of precipitation, and severe drought seasons. Ecosystems and civilisations are already under a great deal of stress due to the effects of climate change. A lot of pressure is being put on this. As a result of increased demand for water brought about by urbanisation, municipalities have had to become inventive to deal with water scarcity. Communities are recycling more wastewater, making better use of water in agriculture and industry, and implementing integrated water resource management strategies after the data was published. The municipal government is responsible for carrying out the activities outlined in this article. There are likely more methods to do what is now being done; this is just one of them. Contributing to the ongoing discussions is one of the goals of this study. Regardless of the viewpoint considered, the evidence suggests that the future of China's rivers is an issue of worry on a national, regional, and global scale.

Keywords: Precipitation, Water Shortage, Climatic Unpredictability, China's Rivers, Wastewater.

1. INTRODUCTION

All three of China's major rivers—the Yangtze, the Yellow, and the Mekong—have played crucial roles in the country's development economically, culturally, and socially. Some of the most significant rivers in China are these. The water from these rivers is essential for many activities, including farming, manufacturing, power generation, and urban populations, therefore they play a crucial role in the development and security of the nation. This is due to the abundance of water that they possess, which may be used too many purposes. Rising sea levels and other water scarcity issues are endangering an increasing number of river systems. This threat has been steadily increasing over the last several decades. It is because of the interplay between these two factors that this risk exists. Climate change, altered rainfall patterns, and recurrent droughts have all contributed to a decrease in available water. This occurred for a number of reasons. People are much more concerned about hydrological conditions due to the increasing frequency of floods and the melting of glaciers. Much worse now as a result of this. The issue that has emerged as a result of rapid industrialisation and urbanisation is far more severe than the one that existed before. The reason for this is the high water demand for infrastructure, companies, and residential areas in rapidly expanding cities. Due to increased competition for few resources, environmental degradation and water pollution

have resulted from the uneven distribution of resources between urban and rural areas, as well as between upstream and downstream locations. Because not enough of everything is available, these undesirable results have occurred. The intensifying rivalry for few resources is the primary cause of these unfavourable outcomes (Wang et al., 2022). Talks on sustainable development, water security, and climate resilience have seen China as a major player. The aforementioned issues could be to blame for this. Many countries are involved in these discussions. Adaptive measures have been initiated by a number of American municipalities. Integrated water resource management and wastewater recycling are two methods that have been used to construct "sponge city" programs that can cope with climate change. Plans to begin have also been made. The program's efficacy is impacted by the neighbourhood's socioeconomic status, the available funding, and the regulations governing the program's operation. National and regional initiatives to promote efficiency, conservation, and new technologies have not eliminated this problem. Regardless of whether these restrictions are implemented or not, this assertion remains true. The impact of water scarcity, climate change, and urban adaptation measures on China's major rivers may be examined in this research (Li et al., 2022).

2. BACKGROUND OF THE STUDY

The Yangtze and Yellow rivers are two of China's most important river basins. They are now short on water, which is bad for many sections of the economy. This is making their difficulties worse. Climate change has several implications, including making droughts worse, making it harder to anticipate when it can rain, and making less surface water available for use. The need for water has soared as cities have developed and more people have moved there. Both of these things have made the demand go up. A lot of things might cause a water scarcity in several places. Two of these things are natural catastrophes and more people using water (Chen et al., 2021). Say that this catastrophe has a bad effect on both the world ecological balance and the global socioeconomic stability. Because of this, Chinese communities have had to change what they do to match the new situation. Some of the projects in this group are the Sponge City Program, which aims to make cities more resilient by capturing more rainwater; the South-to-North Water Diversion, which aims to move water from one place to another; and stricter rules on groundwater extraction, which aim to stop people from using this resource too much. This kind of analysis not only clarifies the existing adaptation strategies but also underscores the need for change throughout time. Concluded that each of these aspects has to be taken carefully (Bian et al., 2022).

3. PURPOSE OF THE RESEARCH

The aim of this research is to examine the relationship between water scarcity and the reactions of China's rivers and metropolitan areas to this escalating problem. The emphasis can be on the characteristics of the relationship between the two. To be more specific, the research can focus on China's rivers and cities. This project also wants to find out how water shortages influence the health of important river systems in China, such the Yangtze and Yellow Rivers, and how cities react by making legislation, building infrastructure, and using new technologies. The primary objective of this work is to elucidate the interactions among these factors. The Yangtze and the Yellow are two of China's most important river systems. They can concentrate on the Yangtze River exclusively. The goal of this study is to look at both natural and human responses to find patterns of strength and weakness. To reach this aim, both can be looked at. The information collected from this study can provide insights that may guide strategies for sustainable water management. The results are expected to enhance the current understanding of urban-river interactions in water-stressed environments. Policymakers are also expected to find the data helpful as they try to come up with solutions that can make sure future generations have access to water supplies. A lot of people believe this can happen.

4. LITERATURE REVIEW

This is a big problem in China that is hurting the country's natural ecosystems and its increasing urbanisation. The absence of easily accessible water is an important problem that has to be addressed right now. The quantity of water that is easy to get has dropped a lot because to things like rapid industrialisation, population growth, and climate change. All three of these things have helped it grow, and now this autumn is a direct consequence of how they all worked together. Because of this, a lot of stress has been put on vital river systems including the Yangtze, Yellow, and Hai Rivers. These rivers are stopping things like producing food, making electricity, and bringing water to towns (Yang et al., 2022). At the same time, river water levels are dropping, pollution is rising, and ecosystems are becoming worse. At the same moment, these things are occurring. Because of the circumstance, a number of Chinese municipalities have come up with measures to adapt. Some of these options include severe controls on how much water may be used, recycling wastewater, and big initiatives to move water from one place to another. The purpose of these stages is to find a means to fulfil both the high demand for water and the limited supply. Desalination, smart water management systems, and rainwater harvesting are some of the technological solutions being put into place to make water management more efficient. Even if people are trying to fix the problem, the persistent problems are caused by the imbalance in water resources between the north and south, the rising demand in cities, and the constant needs of industrial activities. Even after considering all of this, there are still concerns. Each of these things has a role in shaping the circumstance. Water management on a national level needs both short-term and long-term solutions since water shortages, river health, and urban adaptation are all interrelated. This is a necessary since these three parts work together in a very complicated way. Everyone in the nation has to observe this rule (Zhou et al., 2023).

5. RESEARCH QUESTIONS

- What is the impact of water scarcity on the cities 'responses through china's main river?
- What is the impact of climate change on the cities 'responses through china's main river?
- What is the impact of china's main river on the cities' responses?

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.

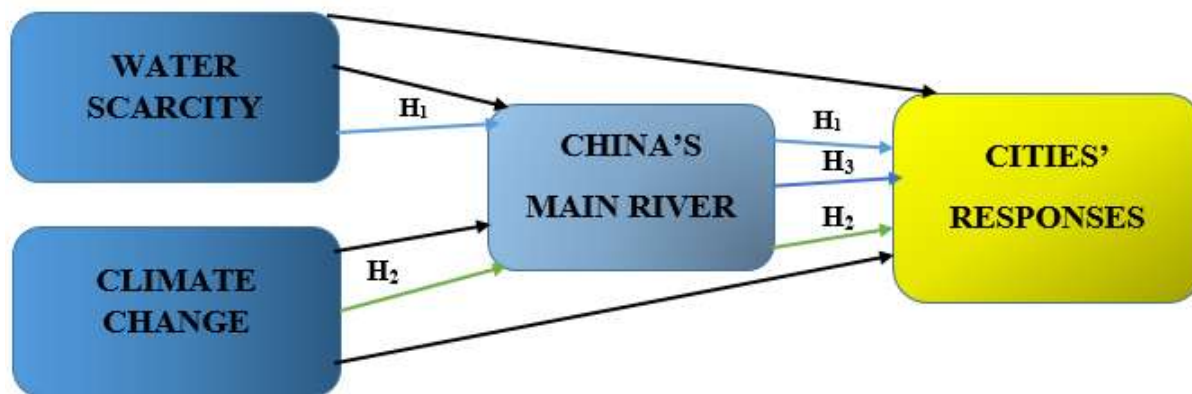
6.2 Sampling: Research participants filled out questionnaires to provide information for the research. Data collection for the study was done using questionnaires. A sample size of 1,463 was determined using the Rao-soft algorithm. Of the 1600 surveys sent out, 1557 were returned; 57 were not included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

When there isn't enough water to meet the present demand, there is a water shortage. This is an example of a water shortage. This situation causes systemic stress in both people and the environment. There are several things that affect it, such as climate change, unpredictable rainfall, over-extraction of groundwater, and increased demand from cities and industries. In addition, a variety of other things have an effect on it. People in northern China are suffering the impact of the country's chronic lack of water. The amount of water that each individual in China's southern areas gets is far more than in the north. This is why. This lack of water has a big effect on river flows, the productivity of farmland, and how easy it is for cities to get water. Cities need to use technology like water recycling, desalination, and stricter rules to make the most of limited water resources and distribute water in a way that lasts. This is being done to make sure that water supply stays sustainable. These steps are being taken to meet the criteria set by the appropriate regulatory bodies (Yan 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 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 (Zhou et al., 2021).

❖ **DEPENDENT VARIABLE**

• **Cities' Responses**

The most densely inhabited and industrialised regions of China are located in the main river basins, making urban centres crucial for resolving water scarcity challenges. China is a great example of this. The current scenario in China serves as a prime example of this. When one considers all of China's cities, this becomes much more apparent. The idea that "cities are responding" is being studied in this study as a dependent variable. The phrase "water management" encompasses the many strategies used by urban areas to control the consumption of finite water resources and adjust to shifting weather patterns. There have been a lot of initiatives by cities to address the problem. This category includes strategies that are focused on community involvement, legislation, technology, and infrastructure. Reducing their dependency on traditional freshwater sources and optimising their resource utilisation, several towns have undertaken technical initiatives such as wastewater recycling, desalination, and the implementation of cutting-edge water management systems. They do this because they wish to cut down on their dependence on these sources. Reducing the risk of floods and increasing groundwater supplies are some goals of "sponge cities," which might be constructed as a solution to the infrastructure crisis (Dang et al., 2023).

• **Relationship between Water Scarcity and Cities' Responses through China's Main River**

In China, the state of the Yangtze, Yellow, and Hai rivers has a big effect on how cities throughout the country respond to water shortages. The Yangtze, Yellow, and Hai are three rivers that fit this description. This system's rivers all flow into each other. There are a number of different reasons why there can be a water shortage. These factors, such as less rain, lower river flows, and too much water extraction, throw off the natural equilibrium of these rivers. In many circumstances, these things might be the main reason for the lack of water. This drop in river flows is a big reason why water is becoming limited, and it's one of the most evident reasons why. City governments need to make sure that there is adequate water for homes, companies, and farms. This demand is expanding. They think that this pressure can only become worse. The river water levels are still going down, pollution levels are going up, and seasonal changes are becoming more dramatic. All of these things are making this situation worse. This is the main reason behind the difficulty. Because of this, local governments have begun to adopt a number of different methods, such as tougher rules for using water, recycling wastewater, restoring rivers, and building large-scale water diversion system infrastructure. These are only a few instances of the ways that have been put into place. These answers are linked to the health of the river. When rivers are healthy, communities can give out water more easily, but when rivers are not healthy, towns have to spend a lot of money on alternate water sources and technologies to save water. If cities can understand how human needs and the health of the river environment are linked, they may be able to find a method to meet both. Then it would be possible to put a stronger plan for managing water into Action River (Zhang et al., 2022).

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

“H₀₁: There is no significant relationship between Water Scarcity and Cities’ Responses through China’s Main River.”

“H₁: There is a significant relationship between Water Scarcity and Cities’ Responses through China’s Main River.”

Table 2: H₁ ANOVA Test

ANOVA					
Sum					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	39588.620	566	5655.517	1055.921	.000
Within Groups	492.770	933	5.356		
Total	40081.390	1499			

This investigation yields remarkable results. The F value is 1055.921, attaining significance with a p-value of .000, which is below the .05 alpha threshold. This signifies the *“H₁: There is a significant relationship between Water Scarcity and Cities’ Responses through China’s Main River”* is accepted and the null hypothesis is rejected.

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

The condition of China's major rivers—the Yangtze, the Yellow, and the Hai—has a lot to do with how Chinese towns deal with climate change. With this knowledge, it may be easier to see how the two are connected. A solid connection backs this up. The Yangtze River System is a great example of this link. Climate change is making extreme weather worse and worse. The increase in droughts, floods, and seasonal changes that have come about because of this have an effect on both river flows and water quality. Because of the changes, there is less freshwater available, which makes it difficult to provide water to towns, farms, and power plants. Making power isn't easy either. These changes also make it harder to produce electricity. Cities are under more and more pressure to use adaptation measures because water levels are rising and rivers are under more stress. Better flood control systems, technology for saving water, restoring river basins, and infrastructure that can stand up to climate change should all be part of these solutions. To decrease the consequences of climate change, certain important steps need to be taken. Rivers that are under a lot of stress are the direct cause of the many difficulties they cause. Because rivers are changing so much, they need to do these things even more. How well rivers are managed for the long term may have a big effect on risk or resilience. The health of a river may either make risks worse or make people stronger. It is possible that any of these two things can happen very soon. The condition of rivers offers a valuable perspective for analysing the effects of climate change on urban areas. To formulate policies that facilitate adaptation to climate change, preserve river ecosystems, and guarantee future water security, cities must understand the interconnections among these three elements. To make these policies, it's important to know how these things are linked. Policymakers need to gather this information so that cities can better deal with climate change (Hou et al., 2021). In response to the above discussion, the researcher has offered the following hypothesis to examine the correlation between Climate Change and Cities’ Responses through China’s Main River.

“H₀₂: There is no significant relationship between Climate Change and Cities’ Responses through China’s Main River.”

“H₂: There is a significant relationship between Climate Change and Cities’ Responses through China’s Main River.”

Table 3: H₂ ANOVA Test

ANOVA					
Sum					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	39588.620	562	5650.517	1054.988	.000
Within Groups	492.770	937	5.356		
Total	40081.390	1499			

This investigation yields remarkable results. The F value is 1054.988, 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 Cities’ Responses through China’s Main River.”* is accepted and the null hypothesis is rejected.”

- **Relationship between China’s Main River and Cities’ Responses**

Famous Chinese rivers like the Yangtze, Yellow, and Hai have a big impact on how cities deal with floods and other water-related calamities. These are some of the most significant rivers in China. These rivers are some of the most vital in the country, which is the most crucial reason for this. Keeping these rivers clean and undamaged is very important for the long-term health of cities. These rivers are where much of the freshwater that people drink, grow, work, and make electricity comes from. Due to these circumstances, something has transpired. When rivers have less water flow, greater pollution, or seasonal variations, towns have to do more to make sure they have enough water and keep people healthy. The purpose of this pressure is to make sure that cities can keep up with their public health initiatives. So, cities also need to put protecting public health first. This happens because rivers are important sources of water for cities. Cities have done things like clean wastewater, limit water use, and restore rivers to make sure there is always adequate water. The purpose of these measures is to make sure there is always enough water (Liu et al., 2022). The purpose of implementing these rules was to make sure there was a steady supply of water. The modifications that are planned can make the water supply less likely to alter. The water levels in these rivers affect what communities decide to do, how fast they do it, and what sorts of projects they start. Taking care of a river system that is both healthy and well-managed is a vital step towards encouraging people to act in a way that is good for the environment. Another reason this relationship exists is because the river system is so vital. When a city's river system is in terrible repair, it has to spend more money on infrastructure, find alternative sources of water, and preserve water. This is the only way to make sure there is enough water (Abedzadeh et al., 2020).

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

“H₀₃: There is no significant relationship between China’s Main River and Cities’ Responses.”

“H₃: There is a significant relationship between China’s Main River and Cities’ Responses.”

Table 5: H₃ ANOVA Test

ANOVA					
Sum					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	39588.620	582	5659.517	1056.668	.000
Within Groups	492.770	917	5.356		
Total	40081.390	1499			

This investigation yields remarkable results. The F value is 1056.668, attaining significance with a p-value of .000, which is below the .05 alpha threshold. This signifies the ***“H₃: There is a significant relationship between China’s Main River and Cities’ Responses.”*** is accepted and the null hypothesis is rejected.”

9. DISCUSSION

Unpredictable weather and rising water demand are causing major issues for cities located in large river basins in China. A major contributor to this issue is the dramatic increase in water use over the last several decades. A person's behaviour is significantly impacted by how fast they can access water, according to the study's findings. Following this line, they can get an overview of the potential research findings. The correlation between scarcity and urban reactions could be better shown by a curve than a straight line. This depicts the couple's connection more accurately. Since the two items do not seem to be related, this situation has arisen. Without a doubt, scarcity is one of the factors that influences urban functioning. The level of urgency and the extent to which each community can contribute to addressing water shortages are both affected by the severity of the crisis. How much and what sort of information is needed depends on how bad the situation is. Considering this helps shed light on the many factors that have contributed to the current state of affairs. Locals in areas where rivers are more vulnerable, like as the Yellow River basin, have moved more swiftly and comprehensively than their counterparts in areas where water supplies are more reliably dependable. Although the Yellow River basin has received the most attention, several river basins have been negatively affected by the current water shortfall. This shortage, which has now expanded to other river basins, is causing a lot of people to suffer. The impacts of this are now being felt in many locations. Crucial to this connection is the process of technical adaptation that takes place in times of limited resources. Sponge city infrastructure, recycling systems, and rainwater collecting have all seen significant increases in construction as a result of the growing need for potable water. The rising demand for water is the main cause of this. Creating sponge towns is also part of this. Be consistent; it is key in this regard. They should give this issue their full attention. Ultimately, the discussion shows that water shortages force communities to take action, and the actions they take are contingent upon the kind, severity, and efficacy of those actions. This highlights the obvious importance of seeing scarcity as a catalyst for innovation and legislative change in order to better prepare for the inevitable continuation of climate change. Achieving sustainable development is the goal of the quest.

10. CONCLUSION

The relationship between how cities in China and the country's major rivers respond shows how important it is for cities to be able to deal with natural water systems. This connection shows that the important interaction is happening. This link occurs because most of China's rivers only flow through the nation. The Yangtze, Yellow, and Hai rivers are under increasing

and more stress because to water shortages, pollution, and climate change. So, cities need to make sure that they have extensive rules in place to make sure that growth is sustainable and that water supplies are always available. They are doing this to make sure that there can be enough water. This transformation has happened because there is more and more demand on these rivers. River health has to be a top priority if they want to make sure they have enough water for the long future. The state of these rivers has a big effect on how successfully urban solutions operate. That helps me understand why this happened. The river's condition directly affects how well this method works right now. If they want to construct cities that can handle future water crises, they need to enhance river management, boost infrastructure, and make sure that urban growth includes protecting the environment. These are all things that should be done. Everything we've spoken about so far is an example of something that has to be done. To meet the requirements, they need to complete the following things.

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