Problem Chosen	2022 MCM/ICM Summary Sheet	Team Control Number
B		**Team34**

Lake Mead waters level prediction model by difference method

Summary

Climate change and human activities have reduced water resources and depleted lakes and rivers. Lake Mead's water levels are falling due to droughts caused by climate change and increasing water use by surrounding residents.In addition, we evaluated the relationship model of elevation, area, and volume.

By discussing the factors that affect the inflow, outflow and loss of Lake Mead and analyzing their impact on the water volume and water level of Lake Mead, this paper points out how it affects the elevation, area, and volume of Lake Mead, and deduces the relationship between the three.

For the analysis of water level changes in Lake Mead, we established two models: a quadratic equation based on the water level data of the most recent dry period in 2021 and a difference equation based on the monthly water level changes from 2005 to 2020, to determine The dry period of Lake Mead and analysis of its overall water level pattern, forecast the future water level changes in 2025, 2030 and 2050, and analyze and evaluate our two models, found that the latter is more accurate, and from the two models can be It can be seen that the water level in the future is generally lower than the water level in previous years.

The reduction in water volume and water level in Lake Mead means that water resources are decreasing, and wastewater recycling and reuse is an effective water recycling measure. Taking into account the decisions local leaders may make and the priorities that will influence our planning, we have developed the principles behind a sound wastewater recycling plan and plan, and measured the impact of the factual plan. Then, we assessed whether our plans were reasonable.

We conclude our investigation with a non-technical news article summarizing our findings and our recommendations for wastewater recycling.

Keywords: water level; language modeling; human activity; biological factors; wastewater recycling; quadratic equation; difference equation

Contents

1 Introduction

1.1 Other Assumptions

1. It is assumed that the direct factors affecting the water level of Lake Mead are related to meteorological, human and biological activities.
2. Ignore other factors that don't directly affect it.
3. Ignore short-term fluctuations in trends caused by a species' extinction.

1.2 Symbol description

symbol	meaning	unit
y_t	The water level of Lake Mead in month y feet	inch
$y_{t_{ave}}$	The mean water level of Lake Mead in year y	inch
a_1, a_2, a_3	Three unknowns in the quadratic difference formula	\

Table 1: Symbol description table

2 Analysis of the Problem

Lake Mead is one of the man-made reservoirs on the border of Nevada and Arizona. In 2021, with Lake Mead reaching a record low and the reservoir shrunk to 36the Bureau of Reclamation declared Colorado water shortage. This situation will lead to a reduction in water supplies in Arizona, Nevada and New Mexico and sharp cuts in agricultural water use.

To cope with the drought, it is necessary to define the drought period and develop an effective waste water recycling scheme.

According to the geographical location of Lake Mead and the water level data given in the 3 appendix, a relevant prediction model is established, and information on wastewater recycling is investigated and researched, and wastewater recycling is considered as a solution to water shortages.

According to the relationship between elevation, area and volume, the trend of water volume change in Lake Mead was inferred, and the influencing factors were explored.

The investigation of wastewater recycling requires exploring the factors affecting wastewater recycling efficiency and the policies of local leaders, and finally specifying a wastewater recycling plan and evaluation criteria.

2.1 Analysis of problem 1

According to the water volume relationship function of Lake Mead given in the question, analyze the factors from three aspects of meteorology, human activities and biological activities, and analyze the relationship between these factors and the inflow, outflow and The direction of the impact of the loss. After the model is established, the three factors of meteorology, biology and human activities are used to bring into the functional formula to verify the relationship between altitude, area and volume.

2.2 Analysis of problem 2

For the given Lake Mead water level data, build two models in turn according to the latest data and the water level data from 2005 to 2020, and predict the water level of Lake Mead during the dry period and 2025, 2030 and 2050, and get The dry period under Model 1 is from April to November. For the convenience of display, the water level is 1074.415, 1074.073, and 1074.052 with the average annual water level as a reference. The dry period under Model 2 is about March to September. For the convenience of presentation , taking the average annual water level as a reference, the water levels are 1090.359, 1090.451, and 1090.457.

2.3 Analysis of problem 3

Using textual modeling, considering that the reduction in water volume and water level in Lake Mead means that water resources are decreasing, and wastewater recycling and reuse is an effective water recycling measure, while adhering to sustainability and safety The principle of recycling, treatment and application of wastewater. In order to visualize the impact of plan implementation, consider using GIS visualization technology to conduct 3D modeling of the city, and use GPS tracking technology for wastewater recycling and wastewater treatment to clarify the source and destination of wastewater. Urban air quality and ecological indices are regularly assessed to measure the impact of wastewater, and we have developed a Principles followed by a more reasonable wastewater recycling program and program, and the impact of a factual program measured.

3 Calculating and Simplifying the Model

3.1 Solution of problem 1

Figure 1: Satellite image of Lake Mead

The factors affecting the inflow, outflow and loss of Lake Mead can be meteorology, human activities and biological activities. Lake Mead is at 36.14°N, 114.41°W, on the border of Arizona and Nevada.The global warming trend is rising, and the precipitation of inland lakes continues to decline, resulting in a large water resource decrease in inland lakes and a continuous increase in the area of deserts.

The lake and the geographical environment interact with each other. The most important factors are precipitation and temperature. Precipitation mainly affects the inflow of Lake Mead, temperature mainly affects the evaporation of Lake Mead. By observing the satellite images of Lake Mead through Google Earth, it can be found that there are small islands and floodplains in the lake. This is because during the precipitation process, the river banks and other parts of the river are subjected to uneven forces, and in areas with high precipitation, the river bank corrosion rate is faster, in areas with less precipitation, the corrosion rate is slow. So the probability of small islands formation in the river increases, and lake water volume is affected.

Human activities also affect the inflow and outflow of Lake Mead to a certain extent.Dams were built to provide water for human activities, causing the outflow of water from Lake Mead. According to an overview of Lake Mead on the official website of the National Park Service, Lake Mead is a large reservoir on the main trunk of the Colorado River. When full, Lake Mead is the largest reservoir in the United States, second only to Lake Powell in surface area, which can provide a large amount of water and electricity for human activities. In 1936, the Hoover Dam was completed in Black Canyon in 1936. Its main uses are flood control, navigation, and electricity generation. Others are used to promote the agricultural development of the Colorado Basin and the Imperial Valley and the municipal development of Los Angeles. Lake Mead currently provides municipal water for cities such as Las Vegas, Henderson, North Las Vegas, and Boulder, Nevada, as well as municipal water and irrigation downstream for a total of approximately 25,000,000 people who depend on the water resource of Lake Mead. Over the past 30 years, Las Vegas' population flow has more than doubled, and as population growth increases residential water demand, so will Lake Mead's outflow. Since 1999, the lake's elevation has dropped by about 131 feet. It can also be concluded that population growth has affected the outflow of Lake Mead to a certain extent.

Due to the warming caused by human industrial activity, coupled with the La Niña event, the Pacific Ocean failed to provide sufficient moisture, resulting in extremely dry air in the western United States. In the hottest and driest western United States, much of California receives only 25up the reservoir, the air has become dry, and the hot and dry weather has caused at least 28 6 fires in 8 western states in 2021 alone. Over 640 square miles, especially in Arizona (more than seven fires, 422 square miles), protracted fires have brought rising temperatures and destruction of life and vegetation, which further affects water resources of storage. According to statistics, compared with the same period in previous years, the water level of Lake Mead, which is on the border of Arizona, has dropped by nearly 40 meters in recent years, close to the dead water level of the reservoir. The occurrence of fires, combined with the drop in water levels, has brought about a decline in biodiversity around Lake Mead, the only native fish, the xyrauchen texanus, has been greatly reduced in distribution and abundance, and other sports fish such as : morone saxatilis, pomoxis spp, ameiurus melas, lepomis cyanellus, cyprinus carpio, lepomis macrochirus and etc. all declined to varying degrees . In addition, the rising phosphorus content in the lake due to the discharge of wastewater at the entrance area of the lake, combined with the low productivity caused by the entry of the Colorado River, Virgin River and Muddy River upstream of the lake as bottom flow or intermittent flow, makes the water body more and more suitable for the growth of mussels. , while the adult dreissena rostriformis bugensis, which is a biological threat, in turn has a negative feedback effect on water quality and a large number of fish. This caused a large number of organisms to disappear and water quality to change, resulting in the disruption of the balance in the lake, and the disappearance of a large number of water storage vegetation and microorganisms, making it more difficult for Lake Mead to effectively absorb water resources in the desert area, and the water level dropped seriously.

The second part of the question:

The precipitation factor in the meteorological factors has a positive correlation with the three indicators of the lake: altitude, area and volume. The increase in rainfall will lead to a direct rise in altitude in the early stage. As the rainfall continues to increase, the area of the lake begins to change, and finally the volume changes. The increase in temperature leads to an acceleration of the evaporation rate, the total amount of freshwater in the lake decreases, the elevation gradually decreases, and the area gradually decreases; the decrease in temperature will cause the evaporation rate to slow down, the total amount of freshwater in the lake increases, the elevation rises, and the area expands.

The accumulation of sediments affects the altitude, area and volume to a certain extent. The increased volume of sediment at the bottom of the lake will cause the water level to rise. Due to the irregularity of the edge of the lake shore, its lake area will also change, resulting 7 in changes in lake volume. During 1948-49, 1,425,900 acre-feet of sediment accumulated in Lake Mead. An additional 1,293,100 acre-feet was added between 1948-49 and 1963-64, for a total of 2,716,900 acre-feet, or approximately 12 percent of the original lake volume. The volume of Lake Mead actually increased by 219,150 acre-feet between 1963-1963 and 2001 due to decreased sediment inflow and consolidation of previous sediments.

Human activities such as he increase or decrease of population must also affect these three indicators. An increase in population and an increase in water consumption will reduce its elevation, thereby reducing its area and volume.

Biodiversity in biological factors has a positive correlation with three indicators of lakes: elevation, area and volume. The increase of fish, microorganisms and plants can maintain the balance of the water body and enhance the water storage capacity of the lake. At the same time, the respiration of various microorganisms, animals and plants can generate oxygen and water, which further affects the water content of the lake. The volume of animals and plants themselves will also lead to an increase in the elevation and volume of the lake. In addition, due to the action of organisms such as earthworms, some coastal rocks gradually flow into the lake, increasing the altitude and volume of the lake.

category	factor	elevation	area	volume
meteorology	temperature	-	-	-
meteorology	precipitation	+	+	+
meteorology	sediment	-	-	-
human activities	population	-	-	-
biological	biocenosis	+	+	+

(”-” means negative correlation, ”+” means positive correlation)

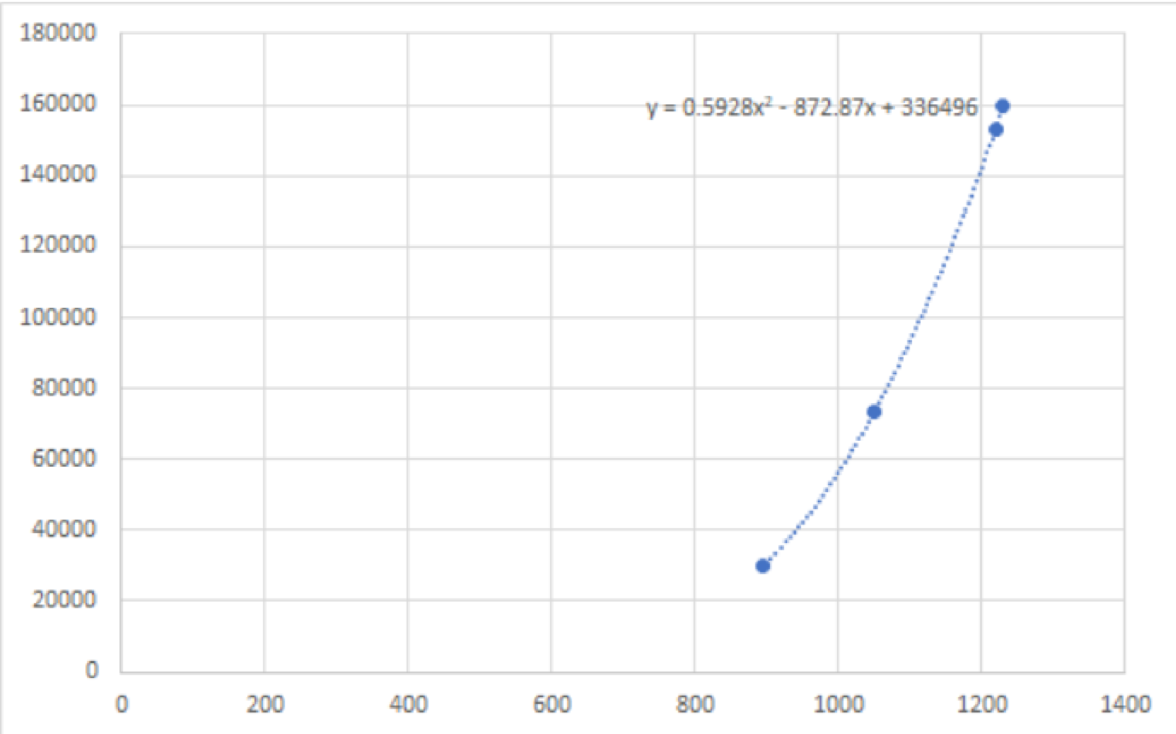
The three indicators of elevation, area, and volume are all affected by the above factors, but there are also mutual influences between these three indicators. Through the observation of Table 1, it can be found that the increase in the volume of the lake during the change in altitude from 89 feet to 1050 feet is significantly weaker than that when the altitude increases from 1050 feet to 1229 feet. The degree of change in lake area The same is true.

To sum up, it can be preliminarily judged that there is a correlation between these three indicators, and the main variable is altitude, and the main variable of area and volume is changed with the change of the main variable.

For the data in Table 1, first consider the relationship between altitude and lake area, 8 and use a second-order polynomial to fit, we can get:

$$y = 0.5928x^2 - 972.87x + 336496$$

The opening of the quadratic curve is upward, there is a minimum value, and the increase rate is not uniform. The shape of Lake Mead is irregular and the depth of the



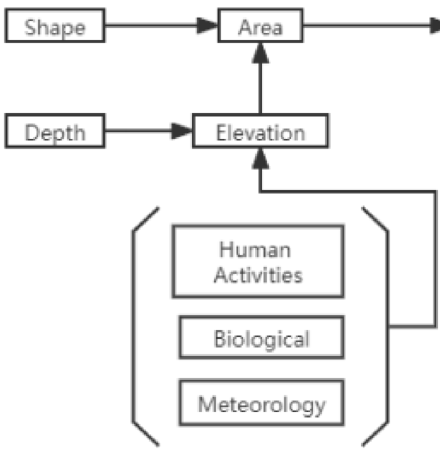
lake is different. The following data can be considered when verifying the relationship between the three indicators: topographic map of the lake shore, topographic map of the lake bottom, the lowest point of the lake rock, and the water surface elevation data. The required information includes the climatic characteristics of the geographical area in which Lake Mead is located, the construction of water conservancy projects and the biodiversity.

Use terrain data to verify the altitude, and consider the remaining two secondary variables after determining the change of the primary variable. The change in area is mainly caused by inflow and loss of water, and the change in volume is affected by elevation and area.

Create a formula that looks like this:

$$V = \sum_{i=0}^{n} x_i - \sum_{i=0}^{n} y_i - \sum_{i=0}^{n} z_i$$

Where Xi(i=1,2,3.....) is the inflow factor, Yi(i=1,2,3.....) is the outflow factor, Zi(i=1,2,3.. ...) is the evaporation loss factor.



The relationship between altitude, area, and volume can be verified by using the three factors of meteorology, biology and human activities to bring in the relationship between inflow, outflow and loss.

3.2 Solution of problem 2

Model 1:

Taking the data onto the most recent year , that is , the water level data onto some mont hs in 2021 , as the known data , and assuming that the pattern of the recent dry period is still going on , the data is set with the x-axis as the month and the y-axis as the water level to establish a coordinate system , and at the same time take the The polynomial form fitting the data has the following equation :

$$y = ax^2 + bx + c$$

The 2021 water level data brought into the table are:

$$y = 0.1999x^2 - 4.9151x + 1094.1$$

It can be seen that after the equation is fitted, there is ,It is relatively close to the accurate data onto 1085.95 . For this reason , the default data for October , November and December are as follows :

$$y_{10} = 1064.939, y_{11} = 1064.2218, y_{12} = 1063.9044$$

From the data plotted for the full year above , the dry period is approximately April to November . Extend the model to all years , let the corresponding function be :

$$y = 0.1999x^2 - 4.9151x + c$$

Then for 2025, 2030, and 2050 there are:

$$y_{2025} = 0.1999x^2 - 4.9151x + 1095.535196$$

$$y_{2025} = 0.1999x^2 - 4.9151x + 1095.193244$$
$$y_{2025} = 0.1999x^2 - 4.9151x + 1095.172345$$

For convenience of expression, the 12-month data are summed and averaged to obtain the average water level of the year:

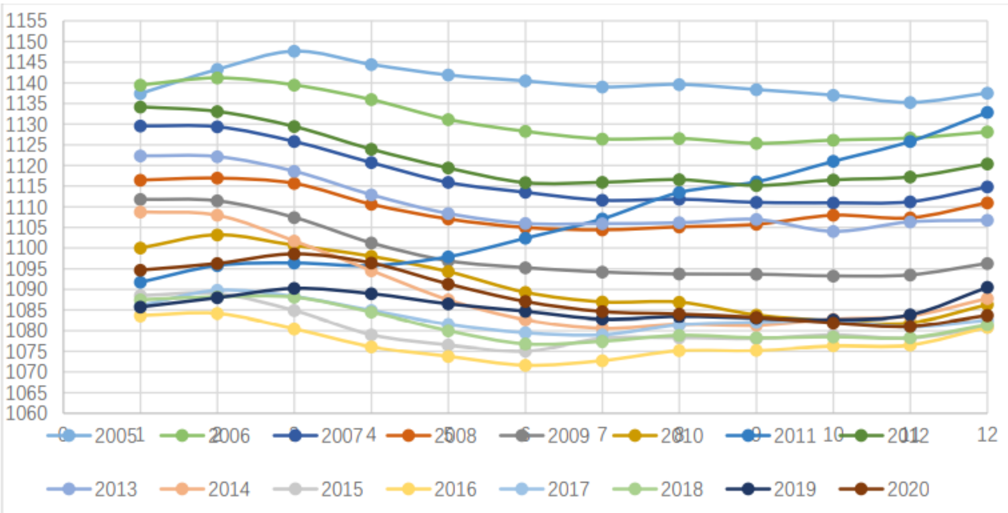
$$y_{2021_{ave}} = 1073.979766666667$$

$$y_{2025_{ave}} = 1074.414962666667$$
$$y_{2030_{ave}} = 1074.073006666667$$
$$y_{2050_{ave}} = 1074.051766666667$$

See the appendix for specific monthly data.

Model 2:

The water level line chart for each month from 2005 to 2020 is as follows:The water level line chart for each month from 2005 to 2020 is as follows:



The water levels after the prediction of the above data is as follows : . As can be seen from the line chart , if the 2005-2020 data are used , and assuming that the pattern of this period continues , it can be seen that during these 15 years , the annual water level showed a trend of first rising , then falls , and finally stabilizing . But there is one straight line that is more anomalous , namely 2011 . After removing the data onto this year , from the line chart , we assume that the initial dry period under this model is scheduled to be March to September . To predict the future changes of the water level , according to the given data characteristics , 12 empirical formulas can be established by month by means of regression analysis , which are respectively used to predict the water level of the same month in the following years . Referring to the results of Model 1 , If it is assumed that the water level does not increase by the same amount year by year but increases by a certain proportion of the water level in the same period of the previous year or years , the difference equation model can be established as follows . Taking January as an example

, to represent the water levels in the first month of year t , establish the second-order difference formula as follows :

$$y_t = a_1 y_{t-1} + a_2 y_{t-2} + a_3$$

Use the least squares method to solve the above, take a1, a2, a3, so that for the known observation data:

$$y_t (t = 1, 2, \cdots, 15, 16 \& t \neq 7)$$

make

$$\sum_{t=3}^{15} [y_t - (a_1 y_{t-1} + a_2 y_{t-2} + a_3)]^2 (t \neq 7)$$

reach the minimum. Take matlab to bring in the data to solve:

$$a_1 = 0.6887, a_2 = -0.0390, a_3 = 384.5757.$$

That is, the second-order difference equation required is

$$y_t = 0.6887 y_{t-1} - 0.039 y_{t-2} + 394.5757$$

It can be seen that the water level in January 2021 in the table is 1085.95 , which is quit e different from the above results . The reason is that if a difference equation is established for each month , the coefficients fitted according to the statistical data may be very different . From another point of view , since the span of the variation on the water level with each month in the same year is smaller than that of the same month in each year , if the difference equation is not established for each month separately , but a difference equation is established for each 12 month , then Yes , set the month number as $t = 1, 2, \cdots, 180,$ let $y_t = a_1 y_{t-12} + a_2 y_{t-24} + a3,$ after bringing in all the data , make:

$$Q(a1, a2, a3) = \sum_{t=25}^{180} [y_t - (a_1 y_{t-12} + a_2 y_{t-24} + a_3)]^2$$

To reach the minimum, it is calculated that

$$a_1 = 0.6937, a_2 = -0.0719, a_3 = 412.4683.$$

That is, the second-order difference equation required is

$$y_t = 0.6937 y_{t-12} - 0.0719 y_{t-24} + 412.4683$$

Then the data for January 2021 is also brought into the forecast value.

$$y_1 81 = 1093.782391$$

It can be seen that the approximate result obtained by the first method is more accurate, and since this method takes into account the water level data of all years and months, there is no need to solve each month separately, resulting in 12 formulas, only All the results can be found in one expression above.

For the convenience of display, similar to Model 1, a weighted average method is adopted, and the corresponding annual average water level is obtained as follows:

$$y_{2025_{ave}} = 1090.358744084337$$

$$y_{2030_{ave}} = 1090.451065369551$$

$$y_{2050_{ave}} = 1090.456800258510$$

See the appendix for specific monthly water level data.
The specific explanation is as follows :
1) . It can be seen from Model 1 that the overall pattern of Lake Mead waters level under this model show a continuous downward trend , and from the data complemented by Model 1 , It can be seen that the dry period in this state is roughly from April to November , although There was a slight rebound in September .
2) . It can be seen from Model 2 that the overall pattern of the water level of Lake Mead under this model shows a trend of first rising , then falling , and finally stabilizing . From the data prediction of Model 2 , It can be seen that the dry period in this state is roughly from March of March . to September .
3) . Model 1 represents the recent drought period . It can be seen that the recent drought 13 period lasted longer , came later , and declined more rapidly than before . This also reflects that on the context of globalization , various Climate-like , biological and anthropogenic factors pose increasing risks to lakes .
4) . It can be seen that the predicted water level results of Lake Mead in 2025 , 2030 and 2050 in years are as follows :
(1)**Model 1:**

$$y_{2025_{ave}} = 1074.4149626666667$$

$$y_{2030_{ave}} = 1074.0730066666667$$

$$y_{2050_{ave}} = 1074.0517666666667$$

(2)**Model 2:**

$$y_{2025_{ave}} = 1090.358744084337$$

$$y_{2030_{ave}} = 1090.451065369551$$

$$y_{2050_{ave}} = 1090.456800258510$$

Since the parameters of Model 2 are the data onto each year when establishing the expression , it represents a wider statistical significance and covers more comprehensive factors . So it is more scientific , but it cannot be ruled out that a major problem will occur to 2021 , which will cause the water level of Lake Mead to start from now on . If there is a big difference between previous years , then Model 1 based on data onto recent years will be more scientific , but after rectifying a small number of possible factors , the water level prediction expression established by Model 2 will be more accurate and scientific .

3.3 Solution of problem 3

Using natural language processing technology to process literature and reviews related to wastewater recycling. With the advancement of economic development and urbanization, wastewater resources are increasing. To a certain extent, the recycling of wastewater resources can not only improve the urban environment, but also alleviate the urban water shortage.

Wastewater can be defined as consisting of domestic sewage, industrial sewage, and precipitation. Domestic sewage can be measured by domestic water, industrial sewage can be measured by industrial water, and precipitation wastewater can be determined to be a value less than precipitation, which can be summarized by a linear regression equation.

Domestic water mainly comes from residential houses, schools, public places and business units; compared with industrial wastewater, domestic sewage has a higher recycling rate, and the organic matter contained in it needs to be treated when it is recycled. Therefore, the organic matter in domestic sewage is The content affects the recycling efficiency of domestic sewage. 2 main principles are usually considered in wastewater recycling, namely the principle of sustainability and the principle of safety.
(1) Sustainability Principle

Wastewater recycling is in a cycle, that is, from collecting wastewater to purifying wastewater, each step in the process is essential in the cycle and affects the efficiency of wastewater recycling.
(2) Security principle

Wastewater recycling should meet relevant national laws and wastewater treatment

15 standards.

Based on the above principles, applicable and high-precision recycling technologies and relevant legal standards should also be identified in the wastewater recycling plan.

Wastewater recycling plans require relevant government policies to be more effectively implemented, so the decisions of local leaders will also affect the determination of wastewater utilization plan factors to a certain extent.

Following the principle of sustainability, the wastewater recycling and treatment plan needs to determine which types of wastewater can be recycled. When determining the standard, the local ecological environment department usually focuses on its cost, including labor cost, capital cost, and enforceability. The plan needs to meet the greater balance of economy and recycling efficiency.

In addition, the government should improve the public's awareness of water resources protection and wastewater recycling and treatment, and advocate the rational use of water resources, which is conducive to improving sustainability. The above decisions can reduce the waste of water resources and unnecessary wastewater discharge to a certain extent, reduce the burden of wastewater treatment, and reduce the cost of wastewater recycling, including labor costs and capital costs.

The plan is mainly divided into 3 parts: waste water recovery, waste water treatment, waste water application.
(1) Wastewater recovery

Select large urban buildings, residential quarters, etc. as waste water recycling points, and set up small waste water treatment stations at their locations to disperse the waste water generated in the buildings as treatment objects. Decentralized recycling is generally used in small-scale regional wastewater management, and can take the form of independent small sewage treatment stations. This method avoids the construction of large-scale sewage collection and reclaimed water reuse pipe network, and the effective time is short, which greatly reduces the pressure on municipal drainage facilities.

For areas that meet the requirements in terms of capital and technology, large and medium sized wastewater treatment plants can be established for centralized recycling. Compared with the decentralized one, the centralized recycling has a stronger ability to treat the wastewater uniformly, and the circulation operation mode is more superior.
(2) Wastewater treatment

Mainly from three aspects: chemical method, physical method and biological method. Follow the principles of sustainability and security, and pursue maximum benefits. The advantages of each method can also complement each other to improve the recovery 16 efficiency.
(3) Wastewater application

Based on the principle of sustainability, the recycled wastewater can be supplied to urban landscape water bodies to promote the construction of sponge cities. Specifically, it can be applied to urban landscape water bodies.

It can also be used as agricultural irrigation water to irrigate farmland. Urban domestic wastewater can also be used locally based on the principle of neighbors, that is, put into urban sanitation and greening projects. Including street spraying dust, building exterior washing, etc.

In order to intuitively measure the impact of the implementation of the plan, consider using GIS visualization technology to conduct 3D modeling of the city, and use GPS tracking technology for wastewater recycling and wastewater treatment to clarify the source and destination of wastewater. Urban air quality and ecological indices are regularly assessed to measure the impact of wastewater.

3.4 Solution of problem 4

Lake Mead is disappearing and Wastewater treatment needs to be taken seriously

Due to the droughts related to climate change and the increasing water demand of the 25 million people served by Lake Mead, its reservoir's capacity has shrunk to its full capacity. This has drawn our attention to the water resources of Lake Mead and we made an investigation about this problem.

There are many factors that affect the elevation, area and volume of Lake Mead. The main influences we have investigated are meteorology, human activities and biological factor. According to our research, the dry season in Lake Mead is from about March to September, the water levels of Lake Mead are lower throughout the year during this time.From the historical water level data from 2005 to 2020, the water level of Lake Mead is on a downward trend and will continue to decrease in the days to come.

In response to the impact of falling water levels in Lake Mead on water use, wastewater recycling is an effective method. The wastewater treatment plan consists of three parts: recovery, treatment and application, and is based on the principles of sustainability and safety.Among the plans for wastewater recycling and treatment, the government's measures to formulate wastewater treatment plans, provide financial support, encourage technological development, publicize wastewater treatment, and raise public awareness of water recycling are particularly important.

Through the efforts of all sectors of society and taking effective measures, the current situation of Lake Mead will be improved and restored to its original appearance in the future.

4 The Model Results

Using Model 1, the predected monthly water levels in 2025, 2030 and 2050 are as follows:

\	2025	2030	2050
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478

Using Model 2, the predicted monthly water level data of Lake Mead in three years are as follows:

\	2025	2030	2050
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478
Jan	1090.82	1090.478	1090.478

5 Conclusions

It can be seen from the above model results that the results of Model 2 are more concentrated, and when forecasting a given year, the gap between extreme values is smaller and more accurate. This is also the advantage of using all the data as a guide, but It can also be clearly found that in 2050, the data changes are small, which is very weak in anti-interference ability for various emergencies, which is also where the model is unreasonable. The number of iterations in the year is too large, which makes the difference between the data too small. The reason is that the influence of policies and human factors is not considered, but the model can generally predict the water level of Lake Mead and the drought period. , with certain scientific and reference significance.

6 Evaluate of the Mode

The difference model established this time is based on the monthly average water level data, the lowest water level data and the highest water level data, and has good robustness. In the error assessment, the established model was used to calculate the average water level of the known months and compared with its measured value, and the root mean square error was as expected. Therefore, it can be concluded that the model is in line with expectations and has good sensitivity.

7 Strengths and weaknesses

7.1 Strengths

(1) In question 1 , We combined the three aspects of meteorology , human activities and biological a ctivities to analyze the influencing factors , and expressed it in the form of tables and flow cha rts , which are intuitive and easy to understand .
(2) In problem 2 , We established model 1 by polynomial fitting method , established model 2 by differential thinking method , and solved it by approximation method . At the same time , each group of data was considered in the model , and the model was more accurate .
(3) In question 3 , We adopted the method of language modeling , introduced GIS visualization tech 19 nology and 3D modeling and other ideas , combined with literature ideas , and proposed how to solve the problems of wastewater recycling , treatment and application .

7.2 Shortcomings and Improvements

In question 1 , some secondary factors are ignored , and the accuracy will be affected to a certain extent after the model is established . In problem 2 , when the idea of difference is adopted , d ue to the complexity of calculation , the problem is solved in binary form after synthesis , and the accuracy is lost , and when the number of iterations is too high , for example , in 2050 , the effect is not good , and further steps are needed . Improve Using this method of modeling in question 3 has poor visibility and fails to give a complete solution .

7.3 Model to promote

In this paper, a relatively complete process analysis is carried out on the prediction of the water level change of Lake Mead, which has certain reference value for the water level prediction and waste water recycling in the dry period of Lake Mead. However, this paper does not consider a few factors, such as the sudden change of policy. The water level of the lake has dropped rapidly and cannot return to the previous heyday. Policy factors should be added as constraints to optimize the prediction model and improve the Lake Mead water level prediction system.

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Appendices

Appendix A First appendix

Model 1 core code:

```
sum1=0;
sum2=0;
sum3=0;
```

```
sum4=0;
for t =1:12
    y1(t)=0.1999*t^2-4.9151*t+1094.1;
    y2(t)=0.1999*t^2-4.9151*t+1095.535196;
    y3(t)=0.1999*t^2-4.9151*t+1095.19324;
    y4(t)=0.1999*t^2-4.9151*t+1095.172;
    sum1=sum1+y1(t);
    sum2=sum2+y2(t);
    sum3=sum3+y3(t);
    sum4=sum4+y4(t);
end
sum1=sum1/12;
sum2=sum2/12;
sum3=sum3/12;
sum4=sum4/12;
y5=y1';
y6=y2';
y7=y3';
y8=y4';
```

Appendix B Second appendix

Model 2 core code:

1)

```
y0=[1137.4
1139.46
1129.55
1116.46
1111.78
1100.02
1091.73
1134.18
1122.32
1108.75
1088.51
1083.68
1086.08
1087.5
1085.75
1094.68
];
y=y0(3:16);
x=[y0(2:15),y0(1:14),ones(14,1)];
z=x\y
```

2)

```
y0=[
1137.4  1143.25 1147.66 1144.45 1141.89 1140.46 1139.01 1139.61 1138.36 1137.01 1135.
]';
y=y0(25:180);
```

```
x=[y0(13:168),y0(1:156),ones(156,1)];
z=x\y

for t =181:540
    y0(t)=z(1)*y0(t-12)+z(2)*y0(t-24)+z(3);
end
y2025=y0(229:240);
y2030=y0(289:300);
y2050=y0(529:540);
```