

## A water demand prediction

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**Abstract.** To figure out water demands of Billings in the future 30 years, some factor which are related to the water demand are selected to predict. Assume there are no extra factors to cause great changes in the predictions, we depict a prediction figure with the data of the GDP, population, and the personal income. Regression analyses are used to make a prediction with curve fitting model.

The data of Billings, such as the average GDP ( $x_3$ ), population ( $x_1$ ), the personal income( $x_2$ ) and the consumption of water in Billings( $y$ ) in a years in 1985 until 2010, have been analyzed and their scatter diagram shows their linear rate law, which derives:

$$y = a + bx_1 + cx_2 + dx_3 \quad (1)$$

Similarly, to forecast the expected water needs of the city over the next 30 years, we used the regression model to dispose some data of Billings to derive the equations as follows, and the factual regression linear graphs are shown as the figure one.

$$x_1 = a_1 + b_1t_1 + c_1t_1^2 \quad (2)$$

$$x_2 = a_2 + b_2t_2 \quad (3)$$

$$x_3 = a_3 + b_3t_3 + c_3t_3^2 \quad (4)$$

Using the Curve fitting toolbox, we get the parameters values as follows:

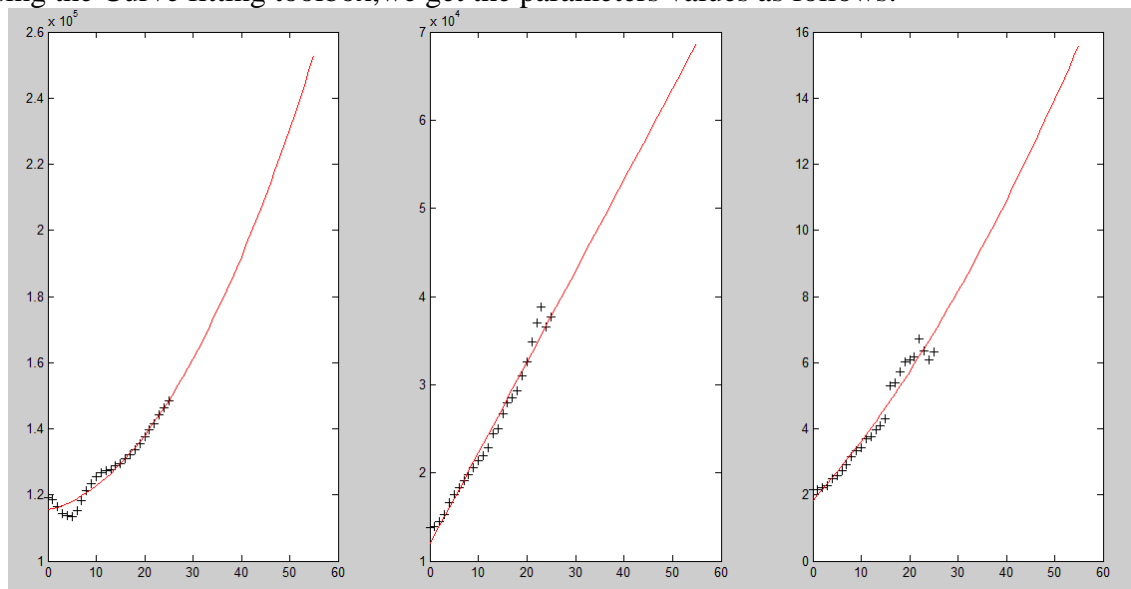


Fig 1: The relation between  $x_1, x_2, x_3$  and  $t$

We calculate the parameters in the equations and then we put our prediction results into a figure which reflects the average water demand per day in a year in Billings. Besides, our prediction about population, personal income and GDP is shown as follows:

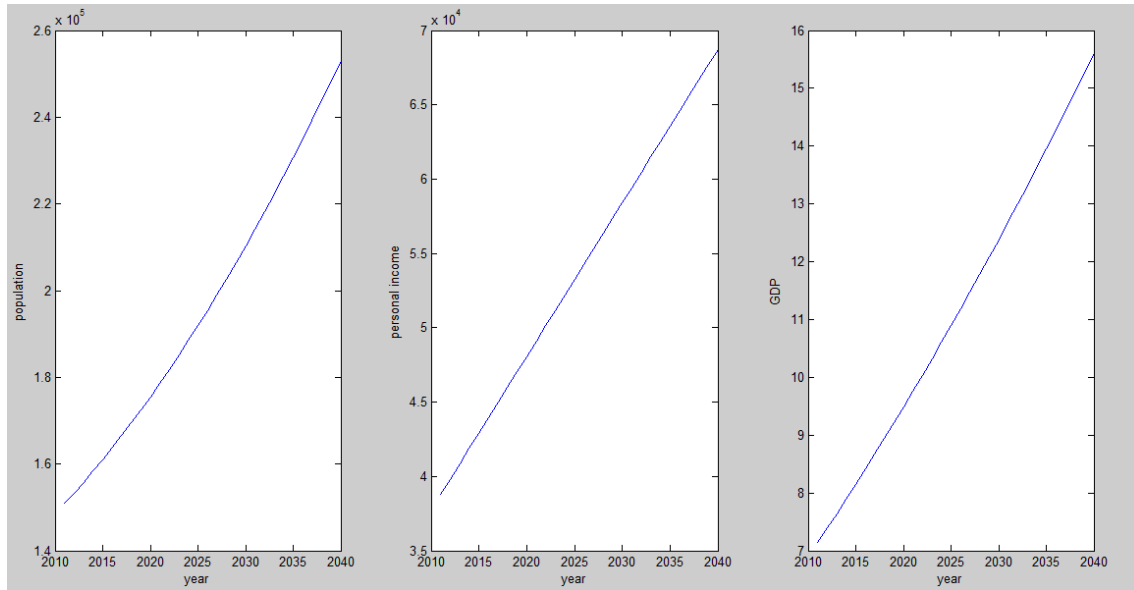


Fig2: The prediction about population, personal income, GDP.

Using the regression analyzing models, we get the parameters values as follows :

$$a = 47.1333 \quad b = 0.0006 \quad c = -0.0008 \quad d = 5.6998$$

After calculating these parameters, we predict the water demand in the future 30 years are:

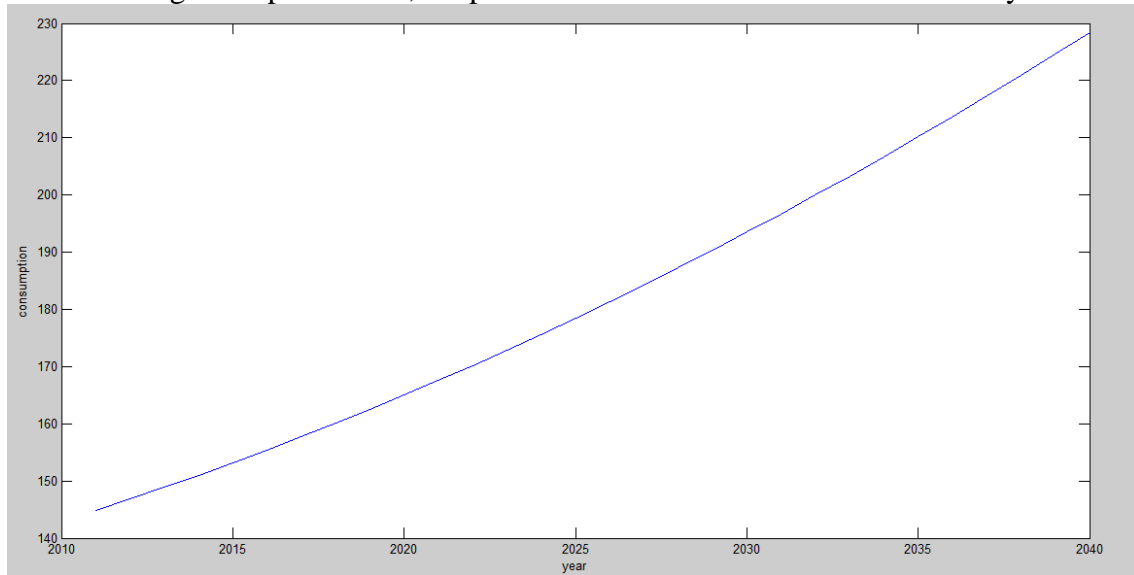


Fig 3: A reflection of the future 30 years water demand

The definite data is shown as follow:

Table 1The definite data from 2017 to 2040

time	2017	2018	2019	2020	2021	2022	2023	2024
consumption	157.6919	160.0587	162.4919	164.9897	167.5533	170.1757	178.3591	182.9697
time	2025	2026	2027	2028	2029	2030	2031	2032
consumption	183.6459	185.387	187.1883	189.0599	191.9911	193.5025	196.7069	199.9704
time	2033	2034	2035	2036	2037	2038	2039	2040
consumption	203.3061	206.7066	210.1669	213.6919	217.2826	220.9381	224.6591	228.4399

In our models, we use 26 years data as fundamental data to forecast the next 30 years. Then we used the first 5 years in the future years to check out the reality of our prediction data. According to the comparison of the data, we find our model is very robust and our prediction is credible.

## **Summary**

From the analysis and the calculation of the demand prediction, the water demands of Billings have a biggish increasing. The government must find some way to meet the demand ,such as using recycled water desalination and rainwater treatment.

## **Reference**

- [1] Qiyuan Jiang, Jinxing Xie, Jun Ye. Mathematical Models. The 4<sup>th</sup> edition. Beijing: China Higher Education Press, 2011.
- [2] Jay Belanger, Jie Wang. Write Right for the American Mathematical Contest in Modeling. The 1<sup>st</sup> edition. Beijing: China Higher Education Press, 2013.
- [3]Information on [http://en.wikipedia.org/wiki/Reclaimed water](http://en.wikipedia.org/wiki/Reclaimed_water)