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Some Specific Methods About Selecting Dams' Address

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Abstract: In this article,we take the Kariba Dam as an example and analyze the number and location of new small dams in detail through Exponential estimation method and Gray Analytic Hierarchy Process。Then,we set up a model and put forward the concrete strategy of regulating water flow. We firstly make a simple analysis of the Zambian River Basin topographic map by Google maps and ARCGIS maps. Thenwe extract the data into MATLAB image analysis. Using MATLAB can help us carry out a preliminary screening along the basic conditions of water flow,height and slope. According to dam site location restrictions, weapply to the GAHP, take local people's opinions, topography, geology, environmental protection, climate, total investment cost and annual running cost as the evaluation index to conduct a comprehensive evaluation analysis on the previously selected regions.Finally,we can select several regions with the highest comprehensive evaluation index as the final address. And the resulting dam system will allow effective control of extreme conditions in parts of the Zambezi River Basin.

Introduction

The Kariba Dam on the Zambezi River is one of the largest dams in Africa.A 2015 report by the Institute of Risk Management of South Africa included a warning that the dam is in dire need of maintenance[1]. If the Kariba Dam collapse, it will threatens the safety of South Africa which have 3.5 million people in it, especially in Republic of Malawi and República de Moçambique[2].And it will destroy 40% of the electricity supply in this region, the dam located in downstream will be completely submerged too.The flood will pour into the another river in Zambia and will threaten Lusaka ,the capital of Zambia[3].

We try to remove the Kariba Dam and replacing it with a series of ten to twenty smaller dams along the Zambezi Riverto solve this problem.So we have to determine the number and location of new small dams in detail.

The model

We determine 31 compatible area to build dam,then we set the model to analyze these 31 place.We order the evaluation index and eventually get the location to build dams.

First we intercept Zambia River watershed topographic map to do simple analysis. The basic location map and the Google satellite maps is as follows:

Figure 1 The basic location map Figure 2 The Google satellite map

Then we analyze the terrain by ARCGIS map and extract the document about dam to make the elevation topographic map as follows:

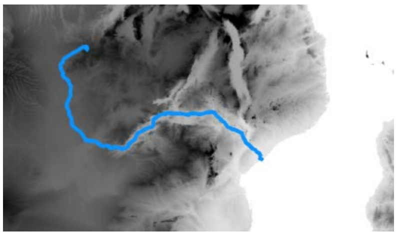


Figure 3 Elevation topographic map

The altitude is 5780m and the low is -182m.

We use arcgis to intercept altitude data,then we use MATLAB to express image and identity the points.Then we get the image about the Zambezi River as Figure 4.We set the distance that the position along the river which is away from the river far point as P,its altitude is Q.We can screen it in a large scope generally to screen out a certain range and initial position as follows:

$$Q = f(P) \quad (6.19)$$

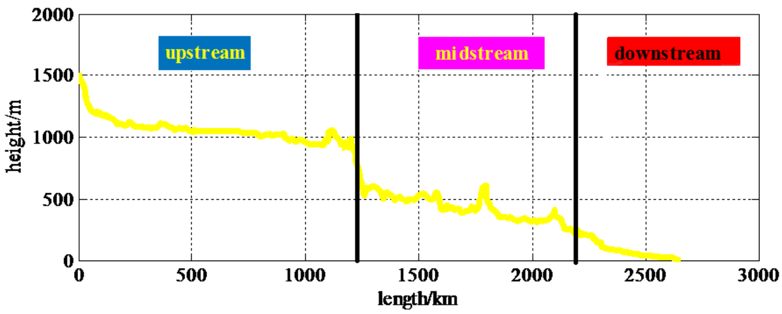


Figure 4 The image about the Zambezi River

Then we can do a wide range of analysis along the river to this question.Firstly we restrict the fall and the gradient to make a initial restriction without considering the canyon topography and the distribution of limestone.The restricted condition is

- The location which we build the dam should has enough altitude intercept and flow.
- The location which we build the dam should has enough gradient.

Finally we find a series of appropriate point.Because the MATLAB simulation results we use is a collection of points and the length of the river is 2660 meters,so we can divide the river into 266 section.When we find the point we get in the last step accounted for 8/10,we can think this section is appropriate to build dam.UsingMATLAB to get the table about the location to build dam in upstream is as follows:

Table 1 The location to build dam in upstream

Serial number	upstream	midstream	downstream
1	40~50	1320~1330	2120~2130
2	50~60	1330~1340	2130~2140
3	60~70	1340~1350	2140~2150
4	160~170	1380~1390	2270~2280
5	240~250	1390~1400	2280~2290
6	400~410	1540~1550	2290~2300
7	490~500	1600~1610	2310~2320
8	800~810	1690~1700	
9	920~930	1810~1820	
10	1000~1100	1840~1850	
11	1130~1140	1860~1870	
12	1160~1170		
13	1220~1230		
14	1230~1240		
15	1250~1260		

Upstream Midstream Downstream

Figure 5 The location to build dams in upstream,midstream and downstream

According to the commonly used method of simple form,the location of these small dams can on the basis of the “the most important,veryimportant,a little important,important,not important”[4].Based on the AHP method’s judgment of the scale we can calculate that

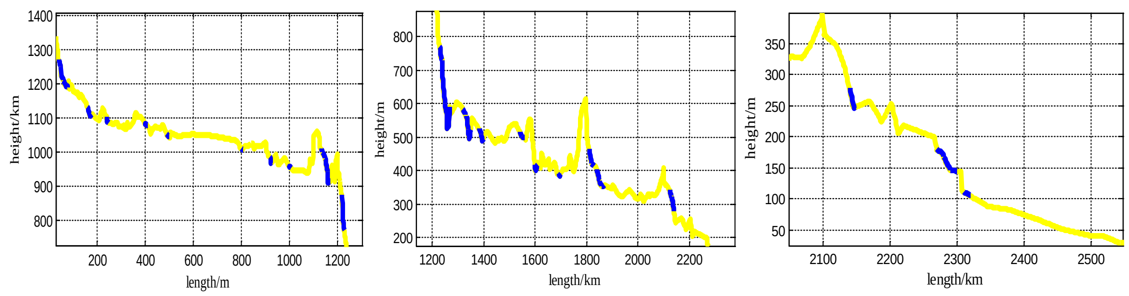
$$B=\{0.122,0.558,0.320\} \tag{6.20}$$

$$B1=\{1\} \tag{6.21}$$

$$B2=\{0.352,0.301,0.143,0.204\} \tag{6.22}$$

$$B3=\{0.442,0.558\} \tag{6.23}$$

Then we can refer to the sum and product method to get the relative weight of corresponding



element in the upper element as follows:

$$W=\{0.122,0.196,0.168,0.080,0.114,0.141,0.179\} \tag{6.24}$$

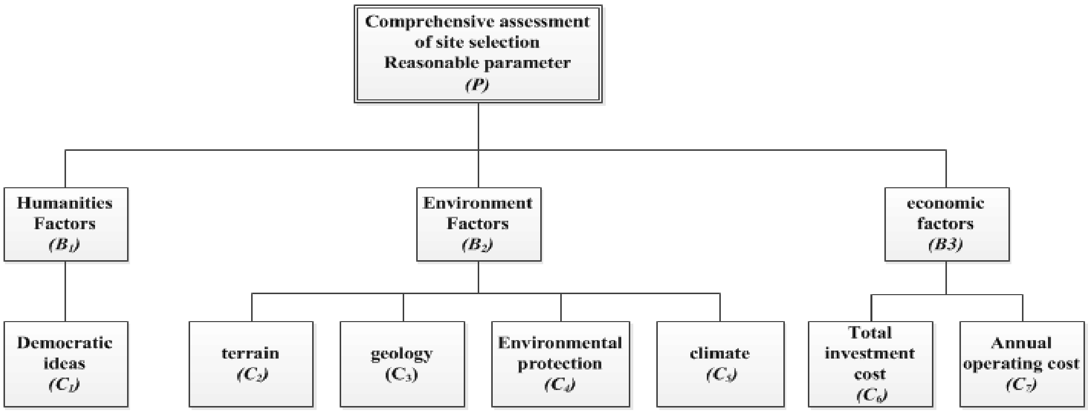


Figure 5 The hierarchy structure chart

We suppose the evaluation index matrix is Dm.If the amount of evaluation experts is m,the expert's number is M1,then we know that

$$M=1,2\ldots m \quad (6.25)$$

The experts' score range is from one to five,according to the expert scoring form we can get the evaluation index matrix as follows:

$$\mathrm{D_m} = \begin{bmatrix} d_{11} & \cdots & d_{1m} \\ \vdots & & \vdots \\ d_{j1} & \cdots & d_{jm} \end{bmatrix} \tag{6.26}$$

Then we determine the gray class scheme evaluation

We can assume the theme about the location is belong to four decision-making gray class($g=4$),they are "excellent, good, medium and poor".According to the computing method we can calculate the gray number and whiten weight function.

As for the evaluation indexC_i,we suppose the gray evaluation coefficient that belongs to evaluation of gray classes is $a_{ig,}$the whole evaluation data that belongs to different evaluation of gray classes is $a_i$then we can calculate that:

$$a_{ig} = \sum_{j=1}^{m} f_g(d_{ij}), a_i = \sum_{g=1}^{4} a_{ig}, i = 1,2,...,n \tag{6.31}$$

From this we can suppose the gray evaluation weight is r,that is

$$r_{ig} = a_{ig} / a_i \tag{6.32}$$

Then we can calculate the gray evaluation weight vector is

$$r_i = (r_{i1}, r_{i2}, r_{i3}, r_{i4}), i = 1,2,...,n \tag{6.33}$$

These gray class vector consist gray matrix as follows:

$$R_i = \begin{pmatrix} r_{11} & \cdots & r_{14} \\ \vdots & \ddots & \vdots \\ r_{n1} & \cdots & r_{n4} \end{pmatrix} \tag{6.34}$$

We get the maximum of r_{ig}as follows:

$$r_i = \max\{r_{i1}, r_{i2}, r_{i3}, r_{i4}\} \tag{6.35}$$

From above we can get the gray evaluation weight matrix

$$B = \{r_1, r_2, ..., r_n\} \tag{6.36}$$

Conclusion

In order to choose the best location from every place,we can use the comprehensive evaluation parameter S to show:

$$S = B * W^T \tag{6.37}$$

Then we rank them from big to small to find the best location.
From the model we can get the final address to build these dams.According to the model, the final selected dam site is 240~250km, 400~410km, 920~930km, 1160~1170km, 1320~1330km, 1540~1550km, 1690~1700km, 1810~1820km, 2140~2150km,2270~2280km,2280~2290km from the source.And this dam system can effectively regulate the flow of water in the Barotseland area during nearly three months of flooding period and the Mozambican river basin during the two-month dry season and two-month flood period.

References

[1]http://www.comap.com/undergraduate/contests/

[2]http://world.people.com.cn/n/2014/0326/c157278-24743704.html

[3]"Kariba Dam". Columbia Encyclopedia, 6th Ed. Retrieved2007-07-31.

[4] Saaty, Thomas L.; Peniwati, Kirti (2008). Group Decision Making: Drawing out and Reconciling Differences. Pittsburgh, Pennsylvania: RWS Publications. ISBN 978-1-888603-08-8