5 基于层次分析法的湖泊评价模型

Evaluation model of lakes based on AHP

层次分析法是将定性与定量相结合的系统分析方法。该方法最适宜于解决那些难以完全用定量方法进行分析的决策问题。我们在充分考虑湖泊生态系统实际情况的基础上,从湖泊生态特征、自然功能和社会环境3个方面的评价指标中筛选出7项指标。我们运用层次分析法建立了湖泊的评价模型。

An[alytic hierarchy](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E5%AE%9A%E6%80%A7%E4%B8%8E%E5%AE%9A%E9%87%8F%E7%9B%B8%E7%BB%93%E5%90%88) [process method](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E5%AE%9A%E6%80%A7%E4%B8%8E%E5%AE%9A%E9%87%8F%E7%9B%B8%E7%BB%93%E5%90%88" \t "_blank) is [a kind](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E5%AE%9A%E6%80%A7%E4%B8%8E%E5%AE%9A%E9%87%8F%E7%9B%B8%E7%BB%93%E5%90%88" \t "_blank) of [qualitative](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E5%AE%9A%E6%80%A7%E4%B8%8E%E5%AE%9A%E9%87%8F%E7%9B%B8%E7%BB%93%E5%90%88" \t "_blank) and [quantitative](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E5%AE%9A%E6%80%A7%E4%B8%8E%E5%AE%9A%E9%87%8F%E7%9B%B8%E7%BB%93%E5%90%88" \t "_blank) [analysis](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E5%AE%9A%E6%80%A7%E4%B8%8E%E5%AE%9A%E9%87%8F%E7%9B%B8%E7%BB%93%E5%90%88" \t "_blank) of multiplicate [objective](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E5%AE%9A%E6%80%A7%E4%B8%8E%E5%AE%9A%E9%87%8F%E7%9B%B8%E7%BB%93%E5%90%88" \t "_blank) [decision](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E5%AE%9A%E6%80%A7%E4%B8%8E%E5%AE%9A%E9%87%8F%E7%9B%B8%E7%BB%93%E5%90%88" \t "_blank)[,](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E5%AE%9A%E6%80%A7%E4%B8%8E%E5%AE%9A%E9%87%8F%E7%9B%B8%E7%BB%93%E5%90%88" \t "_blank) which is applicable in the problem hard to be solved. We sort out 7 indicators from the three aspects of **ecological features,** native functionality and social environment accounting for the real situation of [lake](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E6%B9%96%E6%B3%8A%E7%94%9F%E6%80%81%E7%B3%BB%E7%BB%9F" \t "_blank) [ecosystem](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E6%B9%96%E6%B3%8A%E7%94%9F%E6%80%81%E7%B3%BB%E7%BB%9F" \t "_blank) to apply in the AHP model.

5.1 模型建立 construction of AHP model

湖泊评价模型具体建立过程如下：

The process of building evaluation model is as follows

Step1.建立递阶层次结构模型

Build hierarchical structure

通过查阅相关资料、文献，我们建立了层次模型，结果如下图所示：

We build hierarchy model by looking through materials, the result is as follows

层次结构图

Step2.构造指标间的判断矩阵

Construct judgment matrix

通过当地专家采用1~9标度打分，对各层因素两两间量化判断，可以得到相应的判断矩阵，结果如下图：

We can get corresponding judgment matrix in the way of 1-9 scales to evaluate by expertise and [quantify](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E9%87%8F%E5%8C%96%E5%9C%B0)ing among factors, the results can be seen from the below figure

判断矩阵图

Step3.层次单排序一致性检验

Consistency check of single hierarchical arrangement

定义CI为一致性指标。

We define CI as **Consistency index**

公式8

公式9

一般用CR值判断。当CR<0.1时，认为成对比较的逆对称矩阵可以接受。其中RI取值见下表:

Generally, CR value is used to judge. when CR is less than 0.1, inverse [symmetric](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E9%80%86%E5%AF%B9%E7%A7%B0%E7%9F%A9%E9%98%B5" \t "_blank) [matrices](http://cn.bing.com/dict/clientsearch?mkt=zh-CN&setLang=zh&form=BDVEHC&ClientVer=BDDTV3.5.0.4311&q=%E9%80%86%E5%AF%B9%E7%A7%B0%E7%9F%A9%E9%98%B5" \t "_blank) can be excepted. RI values can be seen in the following table

RI取值表

Step4.层次总排序及组合一致性检验

Consistency check of **total taxis of hierarchy**

设上一层A包含m个因素A1，A2，，，Am。A的层次总排序权值分别为a1，，，am。下一层B包含n个因素B1，，，Bn。这些因素对于Aj的层次单排序的权值分别为b1j，，，bnj。那么，此时B层的总排序权值如下表所示：

Level A has m indexes like A1，A2，，，Am, and the weights of A **total taxis of hierarchy are a1,** am. Level B includes n indexes like B1，，，Bn. Eventually, we could get the weight of B’s to**tal taxis of hierarchy which can be seen in the below according to the A level** single hierarchical arrangement .

总排序表

层次总排序一致性检验为：

We get consistency check of **total taxis of hierarchy**

公式10

当CR<0.1时，认为层次总排序的结果具有满意的一致性。

When CR is smaller than 0.1, the results of **total taxis of hierarchy** are satisfying

At last ,we can get

5.2评价体系的建立

The construction of evaluation system

对于上面得到的评价模型，我们将各项指标都取得最有值。此时得到的结果作为最好情况。我们规定此时为一级。然后，将各个指标取最坏值。我们此时得到的结果为最坏情况。我们规定此时为六级。我们将最好情况到最坏情况评价分为六部分。

We fetch optimal values from all indictors as the best condition for the evaluation model. we define this condition as the first level. On the contrary, the worst condition can be got and defined as six-level, so the condition can be divided into six levels

6 模型的应用

**Application of the Model**

6.1 评价模型在巢湖的应用

The application of evaluation model in Chao Hu

6.11巢湖评价体系的建立

The construction of evaluation system on Chao Hu

我们收集巢湖各评价指标最优值如下表：

We collect the best values of evaluation index as follow

各指标最优值表

带入模型，得到最优值为，，

Plugging values into model, we obtain the best evaluation value：

同理，得到最差值为：

In the same way , the worst evaluation value is

所以，得到评价体系分级如下所示：

Evaluation system can be divided as shown below

分级表格

6.12 确定巢湖评价等级

Determine evaluation grade on Chao Hu

我们收集的巢湖各项指标数据如下表所示：

The target data we collect are described in the following table

数据表

带入模型得到评价值为： 所以属于X级

Then we get evaluation value , so it belongs to

6.13结果分析Results Analysis

结合实际，提出一些改进措施；

6.2预测模型在巢湖的应用

The application of forecast model in Chao Hu

6.21水质变化预测

Water quality change prediction

巢湖流域各种类型土地及输出系数结果如下表：

Land use types and export coefficient of Chao Hu catchment are shown in the below