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Research Article

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Forecasting reduction of forest resources based on GM model

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ABSTRACT

In this paper, a reduction of forest resources model which taken Zhejiang province as an example was constructed based on the GM model. The model was constructed in order to predict the reduction of forest resources. The results show that the predication posterior variance ratio test was 0.23, the small error probability was 1.00, the GM model were available for prediction of reduction of forest land resources. The models should not be used with reduction of forest land resources caution for general applications. Future studies on reduction of forest land resources prediction models should develop to different area and size so as to predication reduction of forest land resources more accuracy.

INTRODUCTION

Forest land resources is an important part of forestry resource, is the foundation of forestry development, forest land resources protection quality not only relates to the ecological construction, but also directly affect the economic and social development of the country[1]. Forest land resource is non-renewable, but with continuous use. In order to strengthen the management of forest, for the development of forest resources, improve the ecological environment, economic and social sustainable development is of great significance. The reduction of forest land resources is always shown as forest land size reduces. At present our country forest land area of patients increased year by year, the accurate forecast of the requisition of forest land is an important of way of forecast the forest resources change trends[2]. The GM model is based on grey module concept. It is a good means to study the application of grey model on the anticipation of weapon equipments consumption[3]. The grey system theory is that all random quantity is within a certain range, a certain period of time, change the grey value and grey process. For the amount of gray processing, not to seek its statistical rule and probability distribution, from the original data of irregular but rule, namely the data through a certain way, make it become a regular time series data, to build models[4-6]. It is always applied to nonlinear function approaching[7-9].

However, the reduction of forest land resources process is different from forest resource. How to predict the reduction of forest land resources in order to calculate the forest resource change was an unresolved problem. In this study, we attempt to construct a reduction of forest land resources model which taken Zhejiang province as an example based on the GM model.

EXPERIMENTAL SECTION

2.1 Data

In this paper, the annals reduction of forest land resources between 2000 and 2010 in Zhejiang province. The data collected from the annals statistical data in Zhejiang province.

In this paper, the data was calculated by SPSS (16.0).

2.2 Method

Grey forecasting model based on grey module concept. It is a good means to study the application of GM model on the anticipation of weapon equipments consumption. The grey system theory is that all random quantity is within a certain range, a certain period of time, change the grey and grey process. For the amount of gray processing, not to seek its statistical rule and probability distribution, from the original data of irregular but rule, namely the data through a certain way, make it become a regular time series data, to build models[10-11]. GM (1, 1) model, that is, only the GM model of a variable, the data for time series is a "comprehensive effect". GM (1,1) model:

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = u \tag{1}$$

$$\hat{a} = [a, u]^T \tag{2}$$

$$X_{(0)} = \{x_{(0)}^{(1)}, x_{(0)}^{(2)}, \cdots, x_{(0)}^{(N)}\} \tag{3}$$

$$X_{(1)} = \{x_{(1)}^{(1)}, x_{(1)}^{(2)}, \cdots, x_{(1)}^{(N)}\}, \quad x_{(1)}^{(i)} = \sum_{k=1}^{i} x_{(0)}^{(i)} \tag{4}$$

Where the a and u is undetermined coefficients. Where the $X_{(0)}$ is original data sequence Where the $X_{(1)}$ is once cumulative data of original sequence

$$B = \begin{bmatrix} -\frac{1}{2}(x^{(1)}(1) + x^{(1)}(2)) & 1 \\ -\frac{1}{2}(x^{(1)}(2) + x^{(1)}(3)) & 1 \\ \vdots & \vdots \\ -\frac{1}{2}(x^{(1)}(N-1) + x^{(1)}(N)) & 1 \end{bmatrix} \tag{5}$$

$$Y_N = \left[x_1^{(0)}(2), x_1^{(0)}(3), \cdots, x_1^{(0)}(N)\right]^T \tag{6}$$

Where B is the accumulative matrix and the Y_N is constant term vector. Using the least square method to solve parameter:

$$\hat{a} = \begin{bmatrix} a \\ u \end{bmatrix}^T = (B^T B)^{-1} B^T Y_N \tag{7}$$

The grey parameter into time functions:

$$\hat{x}^{(1)}(t+1) = (x^{(0)}(1) - \frac{u}{a})e^{-at} + \frac{u}{a} \tag{8}$$

The deviation by $\hat{x}^{(1)}$:

$$\hat{x}^{(0)}(t+1) = -a(x^{(0)}(1) - \frac{u}{a})e^{-at} \tag{9}$$

$$\hat{x}^{(0)}(t+1) = \hat{x}^{(1)}(t+1) - \hat{x}^{(1)}(t) \tag{10}$$

$$\hat{x}^{(1)}(t+1) = (x^{(0)}(1) - \frac{u}{a})e^{-at} + \frac{u}{a} \tag{11}$$

$$\varepsilon^{(0)}(t) = x^{(0)}(t) - \hat{x}^{(0)}(t) \tag{12}$$

$$e^{(0)}(t) = \varepsilon^{(0)}(t) / x^{(0)}(t) \tag{13}$$

Where the $\varepsilon^{(0)}(t)$ is difference betweent $x^{(0)}(t)$ and $\hat{x}^{(0)}(t)$. Where the $e^{(0)}(t)$ is the relative error betweent $x^{(0)}(t)$ and $\hat{x}^{(0)}(t)$. Model validation:

$$s_1^2 = \sum_{t=1}^{m} (x^{(0)}(t) - \overline{x}^{(0)}(t))^2 \tag{14}$$

$$s_2^2 = \frac{1}{m-1} \sum_{t=1}^{m-1} (q^{(0)}(t) - \overline{q}^{(0)}(t))^2 \tag{15}$$

$$c = \frac{s_1}{s_2} \tag{16}$$

$$p = \{ \left| q^{(0)}(t) - \overline{q}^{(0)} \right| \langle 0.6745 s_1 \} \tag{17}$$

According to the posterior than c and small error probability p model for diagnosis, when p > 0.95 and C＜0.35, the model is reliable and can be used to predict.

RESULTS

3.1 The reduction of forest land resources

The reduction of forest land resources were divided into 2 type: permanent reduction, temporary reduction, in this paper the reduction of forest land resources refer to the permanent reduction. The reduction of forest land resources data and cumulative in Zhejiang province between 2000 to 2010 was shown in figure 1.

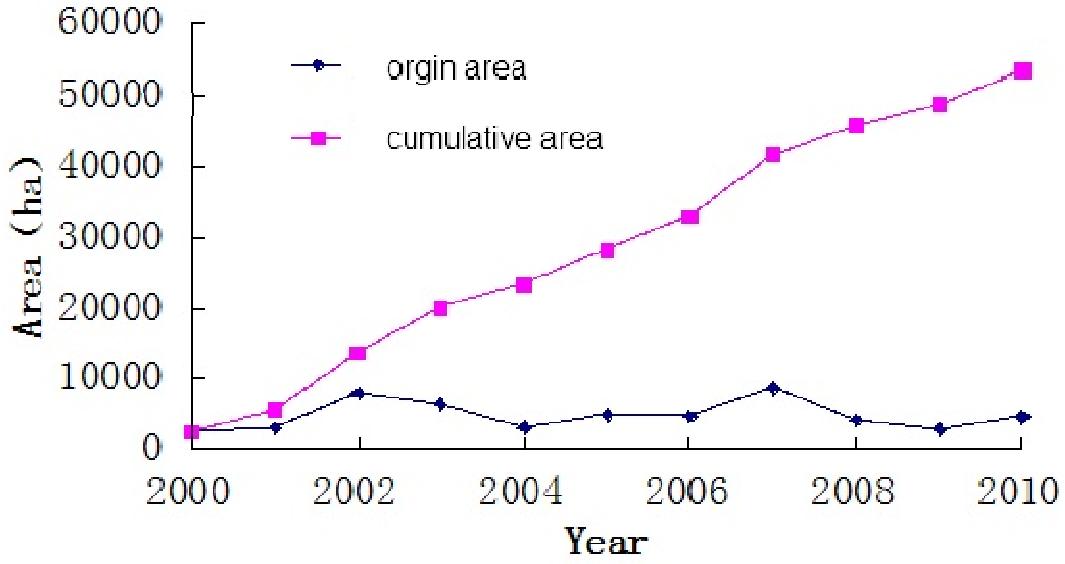

Figure1. 2000-2010 forest land resources reduction data and cumulative in Zhejiang province

3.2 GM（1,1）model

The original data sequence:

X(0)={2546, 3113, 7995, 6453, 3176, 4912, 4701, 8726, 4133, 2924, 4663}

$$\begin{cases} a=0.018393 \\ u=5608.940508 \end{cases}$$

The GM（1,1） model:

$$\hat{x}_{k+1}^{(1)} = -302403.158667e^{(-0.018393)k} + 304949.158667$$

$\bar{\varepsilon}^{(0)} =$ -0.87

$S_1^2 =$ 199532.572

$\bar{x}^{(0)} =$ 4849.2727

$S_2^2 =$ 3899676.744

c=S1/S2=0.2262

$p=p\left\{\left|\varepsilon_i^{(0)} - \bar{\varepsilon}^{(0)}\right| 0.6745S_2\right\} =$ 1.0000＞0.95

Table 1 the predict result of 2011-2020 forest land resources reduction in Zhejiang province

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Area (ha)	4585	4502	4420	4339	4260	4182	4106	4031	3958	3886

As shown in table 1, the total area of prediction forest land resources reduction in Zhejiang province between 2011 and 2020 was 42269.96 ha. The c equal to 0.23 was smaller than 0.35, the p equal to 1.00 was bigger than 0.95. The GM model was available for forest land resources reduction predicts. According to the GM model predicts result, the annals forest land resources reduction is 4227 ha from 2011 to 2020 which is smaller than the annals forest land resources reduction (4849 ha) from 2000 to 2010.

DISCUSSION

In this paper, a reduction of forest land resources model which taken Zhejiang province as an example was constructed based on the GM model. The model was constructed in order to predict the reduction of forest land resources. The results show that the predication posterior variance ratio test was 0.23, the small error probability was 1.00, the GM model were available for prediction of reduction of forest land resources. The models should not be used with reduction of forest land resources caution for general applications. Future studies on reduction of forest land resources prediction models should develop to different area and size so as to predication reduction of forest land resources more accuracy.

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