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An appraisal-analyze method for SWC function of forest in Simian Mountain, China

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Soil erosion is one of the biggest environmental problems. It is urgently needed to understand soil and water conservation capacity of different plantation types so that the best plantation type can be determined. In Qinjiagou watershed of Simian Mountain, Chongqing City, 18 indices were selected from canopy layer, litter layer, soil layer and topography to evaluate the soil and water conservation capacities of four common plantation types by ideal point method. Results indicated that the broadleaf plantation of robur (*Lithocrpus glabra*) and Chinese gugertree (*Schima superba*) (*LS*) has the biggest soil and water conservation capacity. The rank of three other plantation types from big to small is the mixed broadleaf plantation *of* sweetgum (*Liguidambar formosana*), Chinese gugertree and camphor tree (*Cinnamomum camphora*) (*LSC*), the mixed broadleaf-conifer plantation of Chinese fir (*Cunninghamia lanceolata*), Masson pine (*Pinus massoniana*) and Chinese gugertree (*CPS*), and the mixed Pine plantation of Chinese fir and Masson pine (*CP*). Under the same climate and topographical condition, the broadleaf plantation has better soil and water conservation capacity than the conifer plantation. Sensitivity analysis showed that the three most sensitive indices are soil non-capillary porosity, soil aggregation, and soil initial infiltration rate. The litter amount and soil properties are the most important indicators of soil and water conservation capacity of plantations. Therefore, suitable measurements such as deep tillage should be taken to improve the properties of soil under different plantations.

Key words: Ideal point method, soil erosion, soil and water conservation, soil properties, sensitivity analysis.

INTRODUCTION

Soil erosion is one of the biggest environmental problems in the Southwest region of China. Many measurements have been taken to protect soil and water resources. Researches indicated that various types of plantations are all able to reduce surface runoff and soil erosion effectively (Woodward and., Lee 1995; Jiang et al., 2007), and their function was affected by human and natural disturbances (Noske et al., 2010; Uzun et al., 2011). In the upper reaches of the Yangtze River, people have replanted most of farmlands with Chinese fir (*Cunninghamia lanceolata*), Masson pine (*Pinus massoniana*), robur (*Lithocrpus glabra*), sweetgum (*Liguidambar formosan*), camphor tree (*Cinnamomum camphora*) and other tree species. Are these plantation types suitable for reforestation, and are they helpful to protect soil and water? The information is urgently needed to understand soil and water conservation capacity of different plantation types.

The methods proposed to evaluate the soil and water conservation capacities of the forest are based on the use of "runoff plots", which is a labor-intensive and time-consuming process (Wang et al., 2006). The evaluation of soil and water conservation capacity is often based on the single index of coverage (Truman and Bradford, 1990; Deuchras et al., 1999). But the comprehensive assessment of forest's soil and water conservation affected by different factors is a multiple objective decision-making problem, in which a mathematical model needs to be established scientifically. Multiple criteria decision (MCD) method has been used to solve the assessment of forest function for a long time (Kangas and Kangas., 2005; Xevi and Khan, 2005; Lin et al., 2007). Ideal point method is a kind of outranking methods and it is also a good method for multiple objective decision-making. At first, ideal point method was mainly used in the economic and politics field (Henry et al., 1989; Hua and Liang, 1997; Hagemann, 2007). Now, it has been used in diversified fields. Zhang has used ideal point method to solve the fuzzy dynamic environment load dispatch (Zhang et al., 2006). Yang applied the ideal interval method of multi-objective decision-making to comprehensive assessment of water resources renewability (Yang et al., 2004). Qin applied ideal point method to forest harvest regulation (Qin et al., 1997). However, in most previous studies, the weighs of different indices were deemed to be even when they are, in fact, different. The objectives of this paper were: (1) to compare variation of the soil and water conservation capacity of four plantation types in Qinjiagou watershed of Simian Mountain by ideal point method; and (2) to discover the plantation type that has the best soil and water conservation capacity. It will provide a theoretical basis and decision-making reference for the planting and management.

MATERIALS AND METHODS

Study area

Simian Mountain, belongs to the Three Gorges Reservoir Area, is a typical case in terms of its complexity of natural environment and fragility of ecosystem in China. The soil erosion is posing a serious threat to the ecological security and regional sustainable development in upper reaches of Yangtze River. The study area, Qinjiagou watershed (28°31' N - 28°46N', 106°17' E -106°30' E), is situated in the middle part of Simian Mountain, Southwest of China (Figure 1). The forest land of Qinjiagou watershed belongs to the upstream of Yangtze River. The altitude is from 900 to 1500 m. Soils are mainly yellow loam and purple soil, which is infertile, with a depth ranging from 10 to 70 cm.

The representative types in Simian Mountain are mixed forest of Chinese fir and Masson pine (*Cunninghamia lanceolata* × *Pinus massoniana* (CP)), mixed broadleaf-conifer forest of Chinese fir × Masson pine × Chinese gugertree (Schima superba) (*CPS*), mixed broadleaf forest of robur (*Lithocrpus glabra*) × Chinese gugertree (*LS*), mixed broadleaf forest of sweetgum (*Liguidambar formosana*), Chinese gugertree and camphor tree (*Cinnamomum camphora*) (*LSC*). All the four plantation types were planted in 1999, with 1 ha of *LSC*, *CP*, *CPS*, and 0.8 hm^2 of *LS*. The previous shrubs were cut off before new plantations were planted, but the litter is kept. There was no management after the plantations were planted except irrigation in spring.

Samples collection and treatment

Ideal point method

Ideal point, a popular method for multiple objective decision-making, is objective thus avoiding large deviation due to subjective opinion (Henry et al., 1989; Zhang et al., 2006; Hagemann, 2007). That enables the user to resolve the task of multiple criteria decision. There into, the linear function method is the most suitable method for normalizing indices (Walczak et al., 1997; Rafael et al., 2006), did not need expert review (Henry et al., 1990; Hochman et al., 1991). And entropy method is a kind of objective method to determine indices' weights (Guo et al., 2008). That method could reduce the disturbance of subjectivity in the course of assessment, and reflect the contribution of each index to regional ecological safety more objectively (Jia et al. 2006). Therefore, normalizing indices and weighting determination was deal with the above methods (Figure 2).

Sensitivity analysis

Sensitivity analysis is necessary for evaluation (Chen 1987;

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Abbreviations: LS, Broadleaf plantation of robur (*Lithocrpus glabra*) and Chinese gugertree (*Schima superba*); **LSC,** Mixed broadleaf plantation of sweetgum (*Liguidambar formosana*), Chinese gugertree and camphor tree (*Cinnamomum camphora*); **CPS,** Mixed broadleaf-conifer plantation of Chinese fir (*Cunninghamia lanceolata*), Masson pine (*Pinus massoniana*) and Chinese gugertree; **CP,** Mixed Pine plantation of Chinese fir and Masson pine.

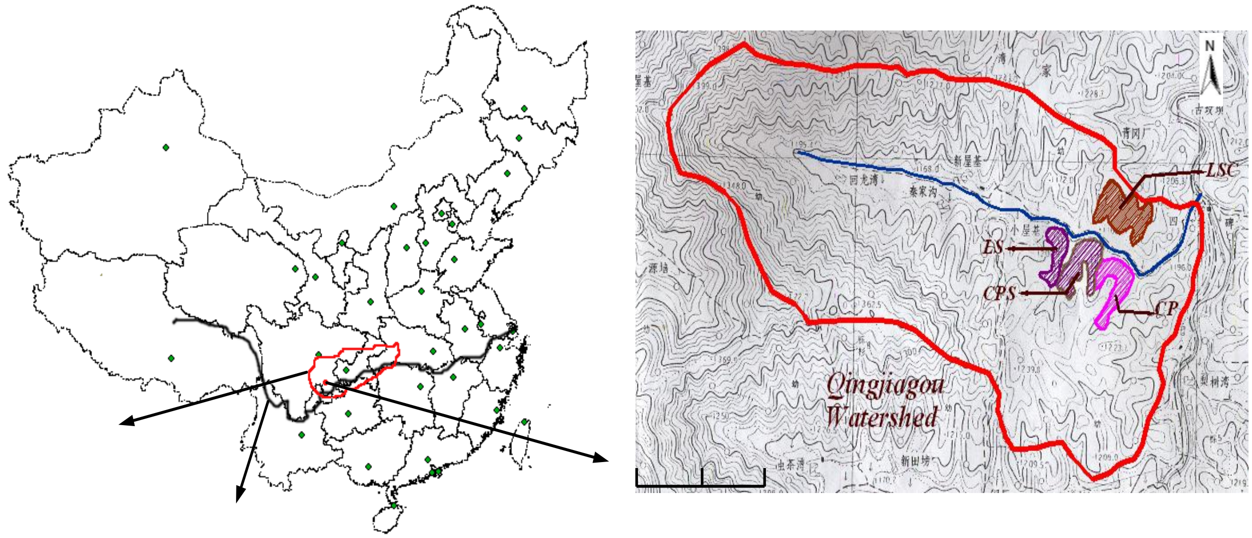

Figure 1. Location of field site.

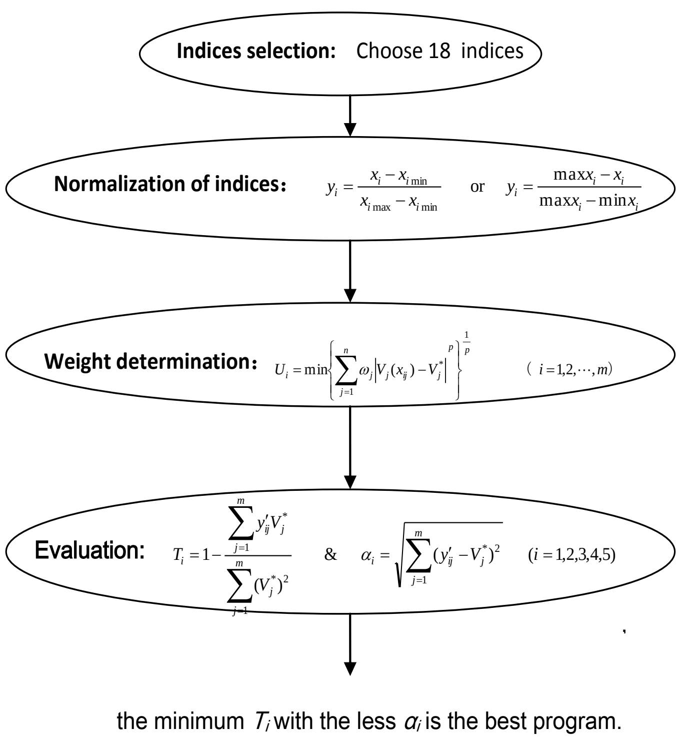

Figure 2. Four-step process of the ideal point method.

Fan et al., 2004). The analysis will determine the certainty of the rank of every two plantation types. Taking $\bar{y}_k$ as the possibly changed value of y'_{ij}, then:

$$\bar{T}_i = 1 - \frac{\sum_{j=1}^{m-1} y'_{ij} V_j^* + \bar{y}_k V_k^*}{\sum_{j=1}^{m} (V_j^*)^2} \quad (1)$$

$$\Delta = \bar{y}_k - y'_{ij} = \frac{(T_i - \bar{T}_i) * \sum_{j=1}^{m} (V_j^*)^2}{V_k^*} \quad (2)$$

when $\bar{y}_k \in \left[\min_i y'_{ij}, \max_i y'_{ij}\right]$, the change of $\bar{y}_k$ will not induce the change of V_k^*. When $\bar{y}_k$ is very close to y'_{ij}, the original rank is not steady. y'_{ij} is the sensitive index. If $\bar{y}_k$ is very close to y'_i when the Δ value belongs to $[0, 0.1]_j$, it means that y'_{ij} is sensitive. And the lower the value is, the more sensitivity indices are. If the numbers of sensitive indices between two plantation types are more than 3, the rank of them is uncertain.

RESULTS AND DISCUSSION

Plant investigation

In July 2009, three 20×20 m^2 plots were established at each plot of four plantation types in study area. The height of all trees was measured. The number of trees in each subplot was counted and recorded. In each 20×20 m^2 plot, four 5×5 m^2 subplots were established for investigation of shrub diversity. The number and names of the different shrubs were recorded. In each shrub plots, two 1×1 m^2 subplots were established for investigation of grass diversity and the names and amounts of the different grasses were recorded. According to measurement, the basic condition and characteristics of each plantation is show in Table 1.

Five 1×1 m^2 subplots were randomly chosen in each 20×20 m^2 plots and leaf litter fall was sampled. A total of 15 leaf litter fall samples were taken in each plot of every plantation type. The maximum water capacity of litter was measured by putting leaf litter fall in water 24 h.

Table 1. Basic condition and characteristics of each plantation.

Items	*CP*	*LSC*	*LS*	*CPS*
Mean tree height (m)	2.87	2.2	3.26	3.83
Coverage (%)	46	70	78	55
Number of shrub species	5	7	7	6
Number of grass species	12	10	9	9

Soil properties

In June 2009, soil samples for physical properties measurements were collected from each location of plantation types (Table 3). Five replicated soil cores for bulk soil density, total porosity and non-capillary porosity were taken in each 20×20 m^2 plot along a diagonal transect. Analyses of physical soil properties were conducted. Three composite surface soil samples were collected from the plots of each plantation. The soil samples were sieved to pass a 2 mm mesh and the percent of soil particles bigger than 2 mm equals the percent of gravel in the soil.

All the physical soil properties and chemical properties were determined by a method described by the Editorial Committee of Soil Physical and Chemical Analysis (Editorial Committee, 1996). Bulk soil density was measured by a core method. Soil particle size analysis was carried out by a hydrometer method. Total porosity was calculated according to the determined particle density. The infiltration rate (IR) of the soils was measured by using a double-ring infiltrometer with a 22 cm outer diameter, a 10.5 cm inner diameter and a height of 25 cm (Song et al., 2007). Organic matter of the soil was determined by an oil bath-$K_2Cr_2O_7$ titration method.

Implementing ideal point method

Values of all the indices

In this study, 18 indices were selected (Figure 3) for ideal point model. That is one is different from the previous research (Truman et al., 1990; Deuchras et al., 1999). There into, two indices, aspects and roots distribution, are qualitative indices obtained by the method of expert's gradation according to the studies about the relationship between indices and soil erosion. And the other 15 indices values are all obtained from field measurements. The scores of two qualitative indices were shown in Tables 2 and 3.

Normalization of indices

The evaluation system is composed of 4 programs (4 plantations) and 18 indices. Then, the original matrix of the evaluation system is $X=(x_{ij})_{4\times 18}$,

$$X=\begin{bmatrix} 46 & 2.87 & 30 & 0.15 & 202.79 & 19.17 & 0.237 & 1.096 & 0.049 & 0.186 \\ 70 & 2.2 & 70 & 0.03 & 191.82 & 16.82 & 0.113 & 1.033 & 0.031 & 0.313 \\ 78 & 3.26 & 30 & 0.043 & 246.94 & 25.43 & 0.134 & 1.139 & 0.097 & 0.238 \\ 55 & 3.83 & 50 & 0.26 & 64.47 & 6.04 & 0.069 & 1.236 & 0.117 & 0.203 \end{bmatrix}$$
$$\begin{matrix} 0.397 & 0.085 & 4.53 & 0.18 & 10.75 & 36 & 90 & 1161 \\ 0.502 & 0.112 & 5.04 & 0.37 & 17.42 & 38.5 & 50 & 1160 \\ 0.484 & 0.127 & 5.24 & 0.35 & 37.92 & 36 & 90 & 1166 \\ 0.525 & 0.126 & 5.29 & 0.30 & 10.08 & 28.8 & 70 & 1170 \end{matrix}\Bigg]$$

The matrix after normalization is $Y=(y_{ij})_{4\times 18}$,

$$Y=\begin{bmatrix} 0 & 0.411 & 0 & 0 & 0.758 & 0.677 & 1 & 0.690 & 0.209 & 0 \\ 0.75 & 0 & 1 & 0.556 & 0.698 & 0.556 & 0.262 & 1 & 0 & 1 \\ 1 & 0.650 & 0 & 1 & 1 & 1 & 0.387 & 0.478 & 0.767 & 0.409 \\ 0.281 & 1 & 0.5 & 0.407 & 0 & 0 & 0 & 0 & 1 & 0.134 \end{bmatrix}$$
$$\begin{matrix} 0 & 0 & 0 & 0 & 0.024 & 0.258 & 1 & 0.9 \\ 0.820 & 0.643 & 0.671 & 1 & 0.263 & 0 & 0 & 1 \\ 0.680 & 1 & 0.934 & 0.833 & 1 & 0.258 & 1 & 0.4 \\ 1 & 0976 & 1 & 0.833 & 0 & 1 & 0.5 & 0 \end{matrix}\Bigg]$$

According to entropy method, the weights of different indices were calculated and shown in Table 4.

Evaluation results

After normalization and weights' determination, the final matrix *Y'* is as following,

$$Y'=(y'_{ij})_{4\times 18}=Y*\omega_j \quad (1)$$

where $Y=(y_{ij})_{4\times 18}$ is the matrix after normalization; ω_j means weights of different indices.

$$Y'=\begin{bmatrix} 0 & 0.016 & 0 & 0 & 0.043 & 0.048 & 0.065 & 0.032 & 0.009 \\ 0.034 & 0 & 0.06 & 0.031 & 0.040 & 0.040 & 0.017 & 0.047 & 0 \\ 0.045 & 0.025 & 0 & 0.056 & 0.058 & 0.072 & 0.025 & 0.022 & 0.035 \\ 0.013 & 0.039 & 0.03 & 0.023 & 0 & 0 & 0 & 0 & 0.046 \end{bmatrix}$$
$$\begin{matrix} 0 & 0 & 0 & 0 & 0 & 0.001 & 0.016 & 0.042 & 0.028 \\ 0.071 & 0.038 & 0.046 & 0.028 & 0.078 & 0.017 & 0 & 0 & 0.031 \\ 0.029 & 0.032 & 0.072 & 0.039 & 0.065 & 0.065 & 0.016 & 0.042 & 0.012 \\ 0.009 & 0.047 & 0.070 & 0.042 & 0.065 & 0 & 0.064 & 0.021 & 0 \end{matrix}\Bigg]$$

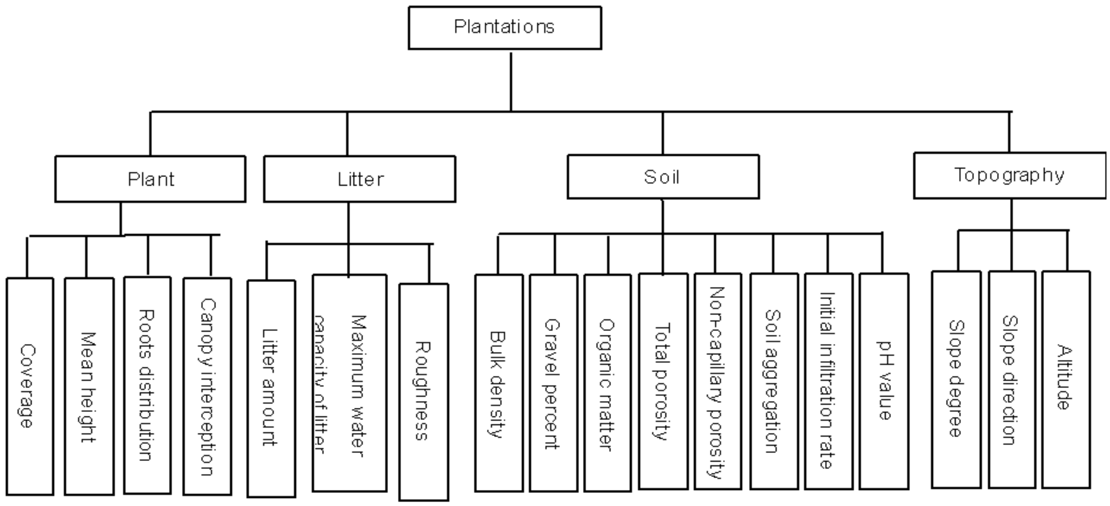

Figure 3. The indices of soil and water conservation capacity assessment.

Table 2. Original values of all the indices.

Indices / **Plant types**	***CP***	***LSC***	***LS***	***CPS***
*X*1 Coverage (%)	46	70	78	55
*X*2 Mean height (m)	2.87	2.2	3.26	3.83
*X*3 Roots distribution	30	70	30	50
*X*4 Canopy interception (mm/mm)	0.15	0.03	0.043	0.26
*X*5 Litter amount (t/(ha yr))	202.79	191.82	246.94	64.47
*X*6 Maximum water capacity of litter (t/(ha 24 hrs))	19.17	16.82	25.43	6.04
*X*7 Roughness	0.237	0.113	0.134	0.069
*X*8 Bulk density (g/cm^3)	1.096	1.033	1.139	1.236
*X*9 Gravel percent (%)	0.049	0.031	0.097	0.117
*X*10 Non-capillary porosity	0.186	0.313	0.238	0.203
*X*11 Total porosity	0.397	0.502	0.484	0.525
*X*12 Organic matter (g/kg)	0.085	0.112	0.127	0.126
*X*13 PH	4.53	5.04	5.24	5.29
*X*14 Aggregation	0.18	0.37	0.35	0.30
*X*15 Initial infiltration rate (mm/h)	10.75	17.42	37.92	10.08
*X*16 Slope degree (^{o})	36	38.5	36	28.8
*X*17 Slope aspect	90	50	90	70
*X*18 Altitude (m)	1161	1160	1166	1170

After normalization, the value of 18 indices all belonged to interval [0, 1]. The maximum was the best. Therefore, the ideal program I_1^* should be composed of the maximum value of each index as follows,

$$I_1^* = (0.045 \quad 0.039 \quad 0.06 \quad 0.056 \quad 0.058 \quad 0.072 \quad 0.065 \quad 0.047 \quad 0.046 \quad 0.071 \quad 0.047 \quad 0.072 \quad 0.039 \quad 0.078 \quad 0.065 \quad 0.064 \quad 0.042 \quad 0.031)$$

$$T_i = (0.634 \quad 0.437 \quad 0.354 \quad 0.523)$$

$$\alpha_i = (0.202 \quad 0.156 \quad 0.121 \quad 0.170)$$

Therefore, the evaluation of soil and water conservation capacity of LS is the minimum, that of CP is the maximum. The second one is CPS, followed by LSC.

Sensitivity analyses

Sensitivity analysis showed us the certainty of the sequence between every two plantation types. It implied the sensitivity of indices to external factors and the

Table 3. Scores of qualitative indices.

Indices	Standard				
	Slight erosion	Moderate erosion	intensive erosion	Very intensive erosion	Severe erosion
Aspects	Northeast	Northwest	Southwest	—	—
Roots distribution	5-50	5-40	5-30	5-25, 10-30	—
Scores	90	70	50	30	10

Table 4. Weights of different indices.

Indices	*X*1 Coverage	*X*2 Mean height	*X*3 Roots distribution	*X*4 Canopy interception	*X*5 Litter amount	*X*6 Maximum water capacity of litter	*X*7 Roughness
Weights	0.045	0.039	0.060	0.056	0.058	0.072	0.065
Indices	*X*8 Bulk density	*X*9 Gravel percent	*X*10 Non-capillary porosity	*X*11 Total porosity	*X*12 Organic matter	*X*13 PH	*X*14 Aggregation
Weights	0.047	0.046	0.071	0.047	0.072	0.042	0.078
Indices	*X*15 Initial infiltration rate	*X*16 Slope degree	*X*17 Slope direction	*X*18 Altitude			
Weights	0.065	0.064	0.042	0.031			

possibility of improving soil and water conservation capacity. *CP* has the minimum T_i value, and has only 3 sensitive indices with other three plantation types. While *LS* has 9 sensitive indices with *LSC* and 6 sensitive indices with *CPS* respectively, which means the sequence of *LS* and *LSC* is uncertain, as well as *LS* and *CPS*. From Equation 12, the Δ value was calculated and shown in Table 5, where sensitive indices were shown by italics.

Table 5 showed that *CP* has three sensitive index with other three plantation types, and *LS* is respectively sensitive to *LSC* and *CPS,* more than three sensitive indices. And soil properties and vegetation characteristics of *LS* are much larger than those of others, especially the soil properties. Conversely, the *CP* has the worst soil and water conservation capacity because the soil properties there, such as bulk density, porosity and aggregation, are much more worse than other plantation types. Therefore, *LS* has the greatest soil and water conservation capacity.

Comparing those plantation types, it can be seen that under the same conditions hardwood forest has a larger soil and water conservation capacity than mixed forest of hardwood and softwood. And hardwood forest has much greater conservation capacity than pure conifer forest. This supports the earlier studies that suggested the hardwood forest has good soil and water conservation capacity in upper Yangtze basin (Shi et al., 2004; Sun et al., 2009). It also coincides with the conclusion that conifer forest has less effect on soil and water conservation than broad-leaved forest (Feng et al., 1998). The results confirm the others conclusions that broadleaf forest has the best soil and water conservation capacity by Wang et al. (2005), who studied on the soil and water conservation capacities of four kinds of forest types by the method of “runoff plots” in Jinyun Mountain, Chongqing city, southwest of China. It also coincides with a previous study which considered 10 indices by comprehensive coordinate method in Simian Mountain (Chen et al., 2009).

While *LS* and *LSC* have no obvious differences in the water capacity of their canopies, *LS* is better than *LSC* in the soil and water conservation capacity based on the amount of litter, water capacity of litter layer, soil organic matter and soil initial infiltration rate. Descroix et al. (2001) found that organic matter was negatively correlated with runoff and soil loss, which is confirmed by this study. There are eight sensitive indices between *LSC* and *LS*, and three of them are very sensitive (soil non-capillary porosity, soil aggregation and soil initial infiltration rate). It means that the soil structure should be optimized to improve the soil and water conservation capacity of *LSC*.

There are six sensitive indices between *LS* and *CPS*, and most of them are litter characteristics and soil properties. This indicates that soil and litter characteristics plays an important role in the forest capacity to conserve soil and water. While *CPS* is better than *LSC* in the water interception of canopy, its soil and water conservation capacity is much worse than that of *LSC*, mostly due to its less litter and poor function of soil.

Litter depth appeared to be an important ecological factor in determining the magnitude of soil loss. The litter layer can protect soil surface, prevent soil detachment, and provide surface roughness that minimizes soil particle movement down the slope and reduces runoff

Table 5. The Δ value of indices X1-X8 and X9-X17.

Plantations \ Indices		X1	X2	X3	X4	X5	X6	X7	X8	X9
						X1-X8				
CP	*LS*	0.2834	0.3271	0.2126	0.2278	0.2199	0.1772	0.1962	0.2714	0.2773
	LSC	0.4043	0.4665	0.3032	0.3249	0.3137	0.2527	0.2799	0.3871	0.3955
	CPS	0.1481	0.1709	0.1111	0.1190	0.1149	*0.0926*	0.1025	0.1418	0.1449
LS	*LSC*	0.1208	0.1394	*0.0906*	*0.0971*	*0.0938*	*0.0755*	*0.0837*	0.1157	0.1182
	CPS	-0.1344	-0.1551	-0.1008	-0.1080	-0.1043	*-0.0840*	*-0.0931*	-0.1287	-0.1315
LSC	*CPS*	-0.2562	-0.2956	-0.1922	-0.2059	-0.1988	-0.1601	-0.1774	-0.2453	-0.2507
						X9-X17				
Plantations \ Indices		**X10**	**X11**	**X12**	**X13**	**X14**	**X15**	**X16**	**X17**	**X18**
CP	*LS*	0.1796	0.2714	0.1772	0.3037	0.1635	0.1962	0.1993	0.3037	0.4115
	LSC	0.2563	0.3871	0.2527	0.4332	0.2333	0.2799	0.2843	0.4332	0.5869
	CPS	0.1039	0.1418	*0.0926*	0.1587	*0.0854*	0.1025	0.1041	0.1587	0.2150
LS	*LSC*	*0.0766*	0.1157	*0.0755*	0.1295	*0.0697*	*0.0837*	*0.0850*	0.1295	0.1754
	CPS	*-0.0852*	-0.1287	-0.0840	-0.1440	*-0.0776*	*-0.0931*	*-0.0945*	-0.1440	-0.1952
LSC	*CPS*	-0.1624	-0.2453	-0.1601	-0.2745	-0.1478	-0.1774	-0.1802	-0.2745	-0.3719

Italics means that the indices were sensitive.

velocity (Descroix et al., 2001; Hartanto et al., 2003; Casermeiro et al., 2004). Soil properties, including bulk density, porosity, and organic matter content, was considered as important indicators of soil erosion (Deuchras et al., 1999; Barthès and Roose., 2002). The results show that the most sensitive indices are from soil layer and litter layer. And plantations whose litter layer and soil layer have good soil and water capacities exhibited better effect of combating soil erosion. It confirms that litter and soil layer under forest play a very important role in protecting soil and water and their capacities reflect the soil and water conservation capacity of forest.

LS, *LSC* and *CPS* have more than three sensitive indices, which mean that their soil and water conservation capacities are very sensitive to external factors such as human disturbances and managing practices. It also means that the soil and water conservation capacity of each plantation types can be easily improved by proper management or reduced by improper management. On the contrary, that *CP* has only 3 sensitive indices means that it is few sensitive to external factors. Since *CP* has the worst soil and water conservation capacity and is not sensitive to external factors, it is hard to improve its soil and water conservation function even if we apply proper managing practices.

CONCLUSION AND SUGGESTION

Soil and water conservation is one of the most important targets of eco-environment construction in Southern China. We found that under the same condition, soil and water conservation capacity of hardwood forest is better than that of mixed forest of hardwood and softwood, and much better than that of conifer forest.

According to the sensitivity analysis, it showed that hardwood *LS* has the best soil and water conservation capacity among the others. Therefore, the mixed broadleaf forest of robur and Chinese gugertree should be the first choice when we implement the 'returning farmland to forest' policy in the Three Gorges area.

It also showed that the soil and water conservation capacity of *CP* is difficult to improve over a short time from now. However, the soil and water conservation capacity of *LS*, *LSC*, and *CPS* can be improved by taking proper managing practices. Litter and soil layer under the forest play a very important role in protecting soil and water. Improving the soil properties should be taken to enhance the soil and water conservation capacity of these plantations. From above discussion, we believe that we have got the same results about the soil and water conservation capacity of different plantation types by ideal point method as by other methods. That proves that ideal point method is suitable for evaluating forest soil and water conservation capacity. Using the ideal point method to evaluate the capacity of soil and water conservation of different forest types can avoid long-time processing measurement, but with more objective and precise results. New research suggests that the ideal point method may be used in conjunction with various optimization techniques to facilitate the selection of optimal combinations of forest types, but little work has been carried out on this approach to date.

Conflict of Interest

The authors have not declared any conflict of interest.

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