# Impact of Soil Erosion on Rural Poverty

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**Abstract** This article gives an overview of the general situation and regional differences of rural poverty in China, and points out that in the rural areas of central and western regions with serious soil erosion, the poverty is particularly prominent. Based on previous studies, we take agricultural GDP as the dependent variable, farmland area, agricultural labor, agricultural capital stock, irrigation area, and consumption of chemical fertilizer as the independent variables, to establish the C – D production function reflecting impact of soil erosion on rural poverty for regression analysis. The results show that farmland, labor, capital, irrigation, chemical fertilizer and other production factors have a positive effect on agricultural GDP; soil erosion has a significant negative effect on agricultural production; in western China, the total factor productivity is the lowest and soil erosion is the most serious. In order to resolve the dilemma of soil erosion and rural poverty, it is necessary to change the extensive mode of agricultural development, protect the ecological environment, and take the road of intensive development of agro-ecology.

**Key words** Soil erosion, Rural areas, Poverty incidence, C – D production function

## 1 Introduction

In recent 20 to 30 years, due to population expansion and extensive growth of the economy in China's rural areas, the degradation of land resources has become increasingly serious. The soil erosion reduces the farmland, abates the agricultural productivity, and causes the deterioration of the ecological environment in rural areas, hampering the sustainable development of the rural community, and making a growing number of rural residents live in poverty. From quantitative point of view, using the provincial data, we conduct regression analysis of the impact of soil erosion on agricultural GDP growth, poverty reduction, and other social and economic benefits, so as to reveal the relations among soil erosion, economic growth and poverty reduction.

## 2 Overview of rural poverty in China

**2.1 Overall situation of rural poverty in China** Since the reform and opening up, China has made tremendous achievements in the cause of rural anti-poverty. Poverty changes in China's rural areas during the period 1978 – 2006 can be seen in Table 1[1-2]. Table 1 shows that although the poor population in 1986, 1989, 1999 and 2003 increased over the previous year, the absolute number of poor people declined from 250 million in 1978 to 21.48 million at the end of 2006, indicating that in the past 28 years, more than 228 million people shook off poverty, an average annual decrease of 9.16% of the poor population; rural absolute poverty incidence declined from 30.7% to 2.3%, decreasing by 28.4 percentage points, an average annual decrease of 9.70%.

At the end of 2006, in the key national poverty alleviation and development counties with the administrative village as unit, the proportion of highways, power, telephone and TV being available, reached 81.2%, 95.8%, 80% and 89.1%, respectively; 70% of rural households in the key counties had access to safe drinking water, and the basic production and living conditions in the poor areas were greatly improved.

Moreover, in the key national poverty alleviation and development counties, the schooling rate of school-age children aged 7 to 15 years old reached 95.3%; the proportion of young laborers who has received the training of agricultural technology and working skills also increased year by year; in the key counties, 73.5% of the administrative villages had health room, and 74.6% of the villages had qualified physician or health worker. Various social undertakings make great strides, improving the quality of the poor population and enhancing the ability of self-development[3].

**Table 1 Poverty changes in China's rural areas during the period 1978 – 2006**

| Year | Poverty standard yuan // person | Number of poor population // $10^4$ people | Poverty incidence // % |
|---|---|---|---|
| 1978 | 100 | 25 000 | 30.7 |
| 1980 | 130 | 22 000 | 26.8 |
| 1981 | 142 | 15 200 | 18.5 |
| 1982 | 164 | 14 500 | 17.5 |
| 1983 | 179 | 13 500 | 16.2 |
| 1984 | 200 | 12 800 | 15.1 |
| 1985 | 206 | 12 500 | 14.8 |
| 1986 | 213 | 13 100 | 15.5 |
| 1987 | 227 | 12 200 | 14.3 |
| 1988 | 236 | 9 600 | 11.1 |
| 1989 | 259 | 10 200 | 11.6 |
| 1990 | 300 | 8 500 | 9.4 |
| 1991 | 304 | 9 400 | 10.4 |
| 1992 | 317 | 8 010 | 8.8 |
| 1993 | – | 7 500 | 8.2 |
| 1994 | 440 | 7 000 | 7.6 |
| 1995 | 530 | 6 500 | 7.1 |
| 1996 | – | 5 800 | 6.3 |
| 1997 | 640 | 4 960 | 5.4 |
| 1998 | 635 | 4 210 | 4.6 |
| 1999 | 625 | 3 410 | 3.7 |
| 2000 | 625 | 3 210 | 3.4 |
| 2001 | 630 | 2 930 | 3.2 |
| 2002 | 627 | 2 820 | 3.0 |
| 2003 | 637 | 2 900 | 3.1 |
| 2004 | 668 | 2 610 | 2.8 |
| 2005 | 683 | 2 365 | 2.5 |
| 2006 | 693 | 2 148 | 2.3 |

Received: August 1, 2012 Accepted: September 30, 2012
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**2.2 Regional differences in China's rural poverty** In accordance with the new classification standard of regions, China is divided into the eastern regions, the central regions, the western regions and the northeastern regions.

(1) The eastern regions: Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan, a total of 10 provinces and cities.

(2) The central regions: Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan, a total of 6 provinces.

(3) The western regions: Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang, a total of 12 regions.

(4) The northeastern regions: Liaoning, Jilin, and Heilongjiang, a total of 3 provinces.

The poor population size and incidence in various regions of China during the period 2000 – 2005 can be shown in Table 2[1].

**2.2.1** The distribution of poor people is imbalanced in various regions, more in the central and western regions and less in the eastern and northeastern regions. In the period 2000 – 2005, the poor population in the central regions, western regions, eastern regions and northeastern regions averaged 7.148 3 million, 17.021 7 million, 1.971 7 million, and 1.91 million, accounting for 25.48%, 60.68%, 7.03% and 6.81% of total poor population, respectively (Fig. 1).

**2.2.2** The central and western regions are still the regions where poor people are concentrated, and especially the western regions have a vast majority of poor population. In the period 2000 – 2005, the share of poor population in the central and western regions in the total poor population averaged up to 86.16%, that is, on the average, among 10 poor people in China, 8 of them were from the central and western regions; in the western regions, the share of poor population in total poor population averaged about 60.63%, up to 63.4% in 2001.

**2.2.3** The overall trend of poor population in various regions is declining, and especially in the northeastern and eastern regions, it declines most. The poor population in China declined from 32.09 million in 2000 to 3.65 million in 2005, a decrease of 26.3%. In the eastern regions, central regions, western regions and northeastern regions, it declined by 31.4%, 17.94%, 26.9% and 45.08%, respectively.

**Table 2 The poor population size and incidence in various regions of China during the period 2000 – 2005**

| Indicator | Region | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Average |
|---|---|---|---|---|---|---|---|---|
| Poor population size//$10^4$ people | Entire country | 3 209 | 2 927 | 2 820 | 2 900 | 2 610 | 2 365 | 2 805.17 |
| | The eastern regions | 207 | 183 | 261 | 217 | 173 | 142 | 197.17 |
| | The central regions | 814 | 683 | 642 | 752 | 730 | 668 | 714.83 |
| | The western regions | 1 944 | 1 856 | 1 742 | 1 698 | 1 552 | 1 421 | 1 702.17 |
| | The northeastern regions | 244 | 204 | 175 | 233 | 156 | 134 | 191.00 |
| Poverty incidence//% | Entire country | 3.5 | 3.2 | 3 | 3.1 | 2.8 | 2.5 | 3.02 |
| | The eastern regions | 0.7 | 0.6 | 0.8 | 0.7 | 0.5 | 0.4 | 0.62 |
| | The central regions | 2.9 | 2.5 | 2.3 | 2.7 | 2.6 | 2.4 | 2.57 |
| | The western regions | 6.9 | 6.6 | 6.2 | 6 | 5.5 | 5 | 6.03 |
| | The northeastern regions | 4.4 | 3.6 | 3.1 | 4.1 | 2.7 | 2.4 | 3.38 |
| Share in the rural poor population//% | Entire country | 6.4 | 6.3 | 9.3 | 7.5 | 6.6 | 6 | 7.02 |
| | The eastern regions | 25.4 | 23.3 | 22.8 | 25.9 | 28 | 28.2 | 25.60 |
| | The central regions | 60.6 | 63.4 | 61.8 | 58.5 | 59.4 | 60.1 | 60.63 |
| | The western regions | 7.6 | 7 | 6.2 | 8 | 6 | 5.6 | 6.73 |

# 3 Analysis of impact of soil erosion on rural poverty

**3.1 Theoretical basis** The differences in the level of agricultural development are one of the factors responsible for unbalanced regional development and unbalanced poverty. Ramatu and Diao's studies have shown that the poverty-alleviation effect of agricultural growth is greater than that of non-agricultural growth. Economic growth (especially the agricultural growth) and the process of industrialization and urbanization in rural areas induced by the economic growth, are the source of power for achieving sustainable rural development and continuous poverty alleviation (Zhang Lei, 2006). However, the rapid growth of agriculture, at the same time, causes the destruction of natural resources and environmental pollution. The destruction of natural resources and environmental pollution not only affects the quality of life of human beings, but also has an enormous negative effect on the long-term growth of agricultural production (Fan, 2006). The serious soil erosion can cause the reduction of arable land, severe degradation of land, and siltation, aggravating the flood disaster, affecting the effective use of water resources, resulting in drought and ecological degradation, and exacerbating the degree of poverty (Wang Lixian, Zhu Jinzhao, 2004).

The results of 3 national soil erosion surveys conducted by the Ministry of Water Resources show that in 1987, the national soil erosion area reached up to 3 661 381 $km^2$, accounting for 38.5% of the land area (the water erosion area of 1 785 282 $km^2$, accounting for 18.8% of the land area; the wind erosion area of 1 876 099 $km^2$, accounting for 19.7% of the land area); in 1997, the national soil erosion area reached up to 3 547 713 $km^2$, accounting for 37.5% of the land area (the water erosion area of 1 640 971 $km^2$, accounting for 17.3% of the land area; the wind erosion area of 1 906 742 $km^2$, accounting for 20.1% of the land area); in 2003, the national soil erosion area reached up to 3 561 368 $km^2$, accounting for 37.6% of the land area (the water erosion area of 1 604 347 $km^2$, accounting for 16.9% of the land area; the wind erosion area of 1 957 022 $km^2$, accounting for 20.7% of the land area). From 1987 to 1997, the soil erosion area decreased by 3.8 percentage points and the water erosion area decreased by 8.1 percentage points, while the wind erosion area increased by 1.6 percentage points. From 1987 to 1997, the soil erosion area decreased by 3.8 percentage points and the water erosion area decreased by 8.1 percentage points, while the wind erosion area increased by 1.6 percentage points; from 1997 to 2003, the soil erosion area decreased by 0.4 percentage points and the water erosion area decreased by 2.2 percentage points, while the wind erosion area increased by 2.6 percentage points. The annual total soil loss reaches as high as 5 billion tons. The soil erosion area, erosion intensity and the degree of harm tend to intensify in some areas. Some regions with serious soil erosion are the regions where poor people are concentrated and the poverty incidence is high, as is shown in Fig. 4.

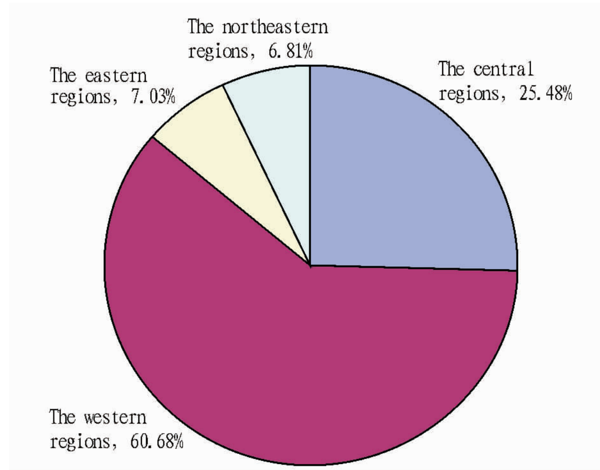


**Fig. 1 The average proportion of poor population in various regions of China during the period 2000 – 2005**

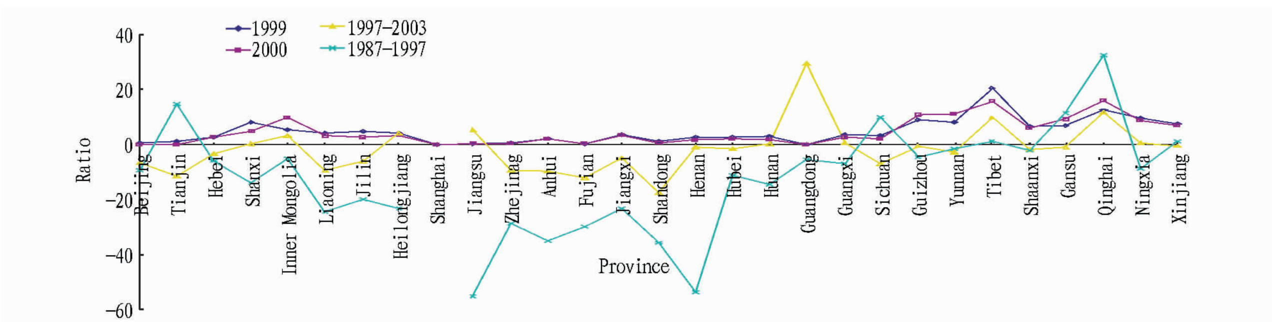


**Fig. 2 Poverty incidence and change rate of soil erosion**

Theoretically, the vast majority of scholars' views all prove the importance of land as a kind of important capital in the sustainable development of agriculture and poverty incidence. Li Zhou, Zhao Yuelong, Guo Laixi *et al* believe that the ecologically fragile areas are geographically related to the poverty-stricken areas. Yang Hankui (1994) believes that poverty is the biggest environmental problem, and when the land resources are so barren that human survival can not be maintained, human will destroy forest to open up wasteland, resulting in soil erosion, karst rocky desertification, environmental degradation, and finally the collapse of the ecosystem. Thomas Reardon (1995) believes that the correlation coefficient of the environment and poverty depends on the depth of the poverty.

Wang Jianwu (2003) points out that there is significant overlap between the poverty-stricken areas and degraded land areas. According to the data of Department of Rural & Social Economic Survey, National Bureau of Statistics of China, we find that in 2003, there were 25.92 million people with low income in the western China, and there were 14.22 million poor people, accounting for 49% of rural poor population. In 2003, the soil erosion area in the western regions accounted for 58% of the national soil erosion area (the wind erosion area accounting for 66% of the national wind erosion area; the water erosion area accounting for 48% of the national water erosion area). The poverty incidence in the western regions is 5 percentage points higher than that in the eastern regions, 3 percentage points higher than that in the central regions; the soil erosion area in the western regions is 53 percentage points higher than that in the eastern regions, 21 percentage points higher than that in the central regions. Soil erosion not only makes the silt flow away, causing the hazard of flood, but also makes soil, fertility, wealth flow away, causing poverty. Soil erosion is the direct factor responsible for poverty in mountainous regions and imbalance in rural economic development.

In theory, it is believed that soil erosion is the greatest obstacle to development of agriculture and rural economy (Qu Futian, Huang Xianjin, Nico Heerink), which will make land degrade, failing to be cultivated, reduce the land productivity and abate land carrying capacity. And there is a causal relationship between soil erosion and poverty.

**3.2 Model design and data selection** In order to estimate the impact of soil erosion and its severity on the economic growth of agriculture, we take agricultural GDP as the dependent variable, and take some variables (farmland area, agricultural labor, agricultural capital stock, irrigation area, consumption of chemical fertilizer, the average annual share of land with soil erosion, the average annual share of soil erosion degree, regional dummy variable) as independent variables, to establish the agricultural economic growth model, using Cobb – Douglas production function model.

The form is as follows:

$$\log(AGDP_{it}) = d_0 + d_1 \times \log(LAND_{it}) + d_2 \times \log(LAB_{it}) + d_3 \times \log(CAP_{it}) + d_4 \times \log(IR_{it}/LAND_{it}) + d_5 \times \log(FER_{it}) + d_6 \times EROSH_{it} + d_7 \times EROGR_{it} + d_8 \times WEST_i + d_8 \times CENT_i + d_9 \times Y_{86t} + d_9 \times Y_{96t} \quad (1)$$

where $d_i(i = 1-9)$ is regression coefficient; $AGDP_{it}$ is the agricultural GDP of province $i$ in year $t$, (based on the comparable prices in 2000); $LAND_{it}$ is farmland area of province $i$ in year t ($10^6$ $hm^2$); $LAB_{it}$ is agricultural labor of province $i$ in year $t$ ($10^4$ people); $CAP_{it}$ is the agricultural capital stock ($10^6$ yuan); $IR_{it}$ is the irrigation area of province $i$ in year $t$ ($10^6$ $hm^2$); $FER_{it}$ is the consumption of chemical fertilizer (converted amount, $10^4$ t); $EROSH_{it}$ is the average annual share of land with soil erosion in province $i$ in period $t$ (%); $EROGR_{it}$ is the average annual share of soil erosion degree in province $i$ in period t (%); $WEST_i$ is regional dummy variable (in China's western provinces = 1; in other provinces = 0); $CENT_i$ is regional dummy variable (in China's central provinces = 1; in other provinces = 0); $Y_{86t}$ is the dummy variable in 1986 (in 1986 = 1; in other years = 0); $Y_{96t}$ is the dummy variable in 1996 (in 1996 = 1; in other years = 0).

The equation includes the traditional factors of production (land, labor and capital), the major factors determining the Chinese agricultural productivity (irrigation, chemical fertilizer) and land quality indicators (area of soil erosion and soil erosion degree).

There are only three years of data on soil erosion information (1986, 1996 and 2002) that can be obtained (For simplification, it is assumed that the first national soil erosion survey (1985 – 1986) was conducted in 1986; in a similar manner, the survey (1995 – 1996) and the survey (2001 – 2002) were conducted in 1996 and 2002, respectively.). There are no data on agricultural capital in Tibet, thus this study does not consider it. In addition, the agricultural share in Beijing, Tianjin and Shanghai is small, also not included into it. So the observation value = 3 × 25 = 75 (In the provincial data, Sichuan includes Chongqing, and Guangdong includes Hainan).

The official statistics do not include the data on agricultural capital stock. In the previous period, the information concerning capital stock was available for IFPRI to research the impact of public investment in rural areas of China, such as all capital information and conversion rate[4]. The previous agricultural production function was estimated using provincial data, but the explanatory variables did not include chemical fertilizer. When collecting the chemical fertilizer data from the Chinese official statistics, it should be noted that the data are the consumption of total chemical fertilizers, and some data are the converted amount. The chemical fertilizer data from different provinces in different years collected in this study are the converted data. The existing information on wind erosion changes sharply contrasts with the reality in Gansu, Qinghai, and especially Shaanxi, so the water erosion data are used as the substitution variable of soil erosion degree. The two kinds of soil erosion indicator signify all land information in the province. Unfortunately, there are no separated data on the soil erosion scale and degree of farmland, so we use the whole soil erosion degree and scale data to replace the soil erosion scale and degree data of farmland, respectively. The soil erosion scale and degree have negative effect on agricultural GDP, while other production factors have positive effect. one-tailed test is used to test the relevant information (Equation deletes all the variables of wrong information.).

The dummy variables of China's western and central regions introduced into the model are conducive to correcting the differences in agricultural production arising from climate and other unobserved variables in the central, western and eastern regions. Similarly, the dummy variables of the year 1986 and 1996 are introduced into the model to test the system differences in three different years in the database. Although the coefficient of the 4 virtual variables can be positive or negative in principle, we expect that the coefficient of the 4 variables is negative.

**3.3 Regression results analysis** The regression results of all the variables in the equation (1) are shown in Table 3. Table 3 shows that all production factors have a positive effect on agricultural GDP. The impact of agricultural labor on agricultural GDP is statistically significantly different from 0, which indicates that the marginal productivity of labor is positive, and China has no surplus labor. The input of chemical fertilizer has a significant positive effect on agricultural GDP. The soil erosion share and degree have a significant negative effect on agricultural GDP, though the estimated coefficient of the latter variables is significantly different from 0 only at 10% significance level. Even if the two soil erosion variables refer to the province's land and are regarded as the substitution variables of arable land drained away, soil erosion has significant negative effects on the agricultural GDP. The estimated coefficients of four dummy variables are negative, significantly different from 0. The absolute value of estimated coefficient of the western China is larger than that of the central China, which indicates that the total factor productivity in the western regions is the lowest. Similarly, the absolute value of the estimated coefficient of the dummy variables in 1986 is greater than that in 1996, also indicating that the total factor productivity in 1986 was the lowest (We use WALD test to test whether the dummy variable in 1986 is equal to that in 1996, and it shows that the equal null hypothesis is rejected. Similarly, the equality of estimated coefficient of regional dummy variable is also rejected.).

**Table 3 Regression results of soil erosion and agricultural production function**

| Variable | Variable | $t$-statistic | Variable | Variable | $t$-statistic |
|---|---|---|---|---|---|
| $LAND_{it}$ | 0.15 * | 1.46 | $EROGR_{it}$ | −0.21 * | −1.36 |
| $LAB_{it}$ | 0.28 *** | 3.12 | $WEST_i$ | −0.20 ** | −2.02 |
| $CAP_{it}$ | 0.08 * | 1.35 | $CENT_i$ | −0.12 * | −1.70 |
| $IR_{it}$ | 0.17 ** | 2.17 | $Y_{86t}$ | −0.20 * | −1.81 |
| $FER_{it}$ | 0.41 *** | 4.01 | $Y_{96t}$ | −0.14 ** | −2.06 |
| $EROSH_{it}$ | −0.004 1 ** | −1.82 | Constant | 1.15 ** | 2.33 |

Note: $R^2$ = 0.95; ***, **, * signify 1% significance level, 5% significance level, and 10% significance level, respectively.

## 4 Conclusions

The study shows that the soil erosion has significant negative effects on agricultural production. The greater the share of soil erosion and the deeper the extent of soil erosion, the greater the negative impact on the agricultural GDP. Due to poverty and low level of productivity, the economic growth is mainly dependent on land, labor, capital and other inputs, forming extensive mode of economic growth. Extensive economic growth has the characteristics of high input, low output, causing the following damage to the ecological environment: (1) It wastes valuable resources, and accelerates the process of resource depletion; (2) It discharges excessive pollutants to the environment. (3) The environmental damage can deteriorate health and cause diseases, resulting in poverty.

In the area of soil erosion, the land productivity is not high; the structure of agricultural production is single; the agricultural capital accumulation is insufficient; poor farmers can not afford to expand reproduction. So they have no choice but to take the road of expanding land for reproduction, and irrespective of the agricultural suitability, turn woodland, grassland, and steep land into farmland. However, the ensuing problems are soil erosion, long-term overloaded operation of land, and degradation of land resource, gradually losing ability to support. With the degradation of land quality and vicious population expansion, it causes the predatory exploitation of the land, triggering a new round of land reclamation. Especially in the food production process, poor backward mountainous areas mostly follow the predatory extensive operation without the ecological awareness, to increase the yield by continuous deforestation, thus resulting in a vicious circle of "population growth, farmland expansion, forest degradation", making it more difficult to solve the problem of food and clothing. Finally, the soil erosion areas are consigned to the long-term poverty trap.

## References

[1] Rural Social and Economy Investigation Division, National Bureau of Statistics. China rural poverty monitoring report[M]. Beijing: China Statistics Press, 2006. (in Chinese).

[2] Rural Social and Economy Investigation Division, National Bureau of Statistics. China rural household investigation yearbook[M]. Beijing: China Statistics Press, 2006. (in Chinese).

[3] WANG LF. Rural poverty population quantity reducing 0.228 billion[EB/OL]. (2007-0526) http://news.xinhuanet.com/fortune/2007-05/26/content_6156519.htm. (in Chinese).

[4] ALHASSAN RM, DIAO XS. Regional disparities in Ghana: policy options and public investment implications, discussion paper[M]. Washington, DC: International Food Policy Research Institute(IFPRI), 2007. (in Chinese).

[5] FAN S, LUO XP, ZHANG XB. Village inequality in Western China[M]. Washington DC: International Food Policy Research Institute (IFPRI), 2006. (in Chinese).

[6] LI Z, SUN RH. Ecological sensitive area and impoverished area correlation research[J]. Rural Economy and Society, 1994(5): 49-56. (in Chinese).

[7] YANG HK. Karst desertification is a kind of geological and ecological disaster[J]. Marine Geology & Quaternary Geology, 1995(3): 137-147. (in Chinese).

[8] QU FT. Sustainable development theory and policy selection[M]. Beijing: China Economic Press, 2000. (in Chinese).

[9] TUERXUNAYI AIBIBULLA, NUERBAYI ABUDOUSHALIKE, ADILIJIANG KUERBAN. Evaluation of animal and plant resources status quo after the reservoir construction in Turks River and protection measures[J]. Meteorological and Environmental Research, 2011, 2(6): 96-98. (in Chinese).

[10] World Bank. China: Overcoming rural poverty[M]. Washington DC: World Bank.

[11] FAN S, ZHANG L, ZHANG X. Growth, inequality, and poverty in rural China: the role of public investments(research report 125)[M]. Washington, DC: International Food Policy Research Institute(IFPRI), 2002.

[12] WANG Y, SHI GQ, CHEN SJ. Soil erosion and poverty——experiences and inspirations drawn from WB loaned loess plateau watershed rehabilitation project[J]. Research of Soil and Water Conservation, 2006, (5): 36-38. (in Chinese).

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## 4 Conclusions

Through overall investigation of the core product of forest tourism in Japan, this paper studied the forest tourism for health care reason in Japan, and concluded the experience in forest bathing field evaluation standard, field construction and personnel training, which provided reference for the development of forest tourism in other Asian countries. Yet, the study and development of forest tourism need cooperation among various subjects and departments so as to realize sustainable development and promote low-carbon traveling.

## References

[1] HANNU RAITIO. Forests and human health-global issues in research and Practice[J]. Japanese Journal of Hygiene, 2008, 63(2): 213.

[2] PIAO FZ, LI JY. Forest medicine II forest treatment in Korea[M]. Asakura Publishing Co Ltd, 2009: 59-66. (in Chinese).

[3] XIAO GM, WU CC. Development and utilization of forest bath tourism in China[J]. Journal of Beijing Second Foreign Language Institute: Tourism Edition, 2008(3): 70-74. (in Chinese).

[4] LI XM. Development of forest bath and bathing place[J]. Jiangxi Forestry Science and Technology, 2004(1): 24-26. (in Chinese).

[5] LI Q. The function o forest bath[J]. Japan's Anti Aging Medical Journal, 2009, 5(3): 50-55. (in Chinese).

[6] MIYAZAKI RAN. Physiological reaction on forest environment: Comfort evaluation of forest environment factors[J]. Wood Industry, 2007, 62(10): 442-447. (in Chinese).

[7] HIRANO HIDEKI. Forest, environment policy and forest treatment[J]. Japanese Journal of Hygiene, 2007, 62(2): 269-272. (in Chinese).

[8] KOBAYASHI AKIO. Cure space of forest[J]. Japanese Journal of Hygiene, 2007, 62(2): 275-276. (in Chinese).

[9] KAGAWA TAKAHIDE, IGAWA HARAHIROHITO. Study on promenade in forest[Z]. LRJ70(5), 2007: 597-600. (in Chinese).

[10] MIYAZAKI RAN. Naturality and comfort[J]. Japanese Journal of Hygiene, 2007, 62(2): 272-274. (in Chinese).