

Ecological Restoration in South China and its Importance both in Sustainable Development of Society and Economy and in Reducing the Impact of Global Change

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1 Ecological restoration is one of the key issues in the sustainability transition

Among the many effects that cause the reduction of biodiversity, the global deforestation that brought by the pressure of the population growth and of the increase in consuming natural resources by human society takes the most important part. The extent of soil degradation induced by human activities since 1945 was evaluated as 2 billion hm^2 , or 17% of Earth's vegetated land, in a recent study sponsored by the United Nations Environment Program (UNEP). Of this, 750 million hm^2 (38%) are classified lightly degraded (defined as exhibiting a small decline in agricultural productivity and retaining full potential for recovery); 910 million hm^2 (46%) are moderately degraded (exhibiting a great reduction in agricultural productivity; amenable to restoration only through considerable financial and technical investment); 300 million hm^2 (15%) are severely degraded (offering no agricultural utility under local government systems; reclaimable only with major international assistance); and 9 million hm^2 (0.5%) are extremely degraded (incapable of supporting agriculture and unreclaimable)(figure 1). It is reported that each year 1-4 percent of the global forest is destroyed. One example is in Philippine. From 1940 to 1990, the area of tropical forest in Philippine reduced from 160,000 km^2 to 50,000 km^2 , while the agricultural land area increased from 50,000 km^2 to 72,000 km^2 and the degraded land area increased from 62,000 km^2 to 75,000 km^2 at the same time. After the forest is transformed to agricultural land, slowly but steadily, the topsoil is eroded, the land's productivity reduced, and as a result, the land is abandoned when it is not profitable any more to maintain the land. Then the weeds invade, and the forests change to degraded land eventually. Coming with the degradation of the land, the biodiversity reduces. The invasion of the alien species that often accompanies the land degradation can accelerate this trend. According to the statistic, 100 of the total 3800 mammal species, 139 of the total 9000 bird species have disappeared since last century, and 600 animal species and 25000 plant species is under the danger of extinction.

In China, the forest ecosystems suffer serious lost because of the disturbance brought by human's activity. The area of the degraded land is up to 1,500,000 km^2 , and the biodiversity reduces obviously under such circumstance. In South China the area of degraded land is 400,200 km^2 . Among the degraded lands, 233,400 km^2 are lightly degraded land, 80,000 km^2 are medially

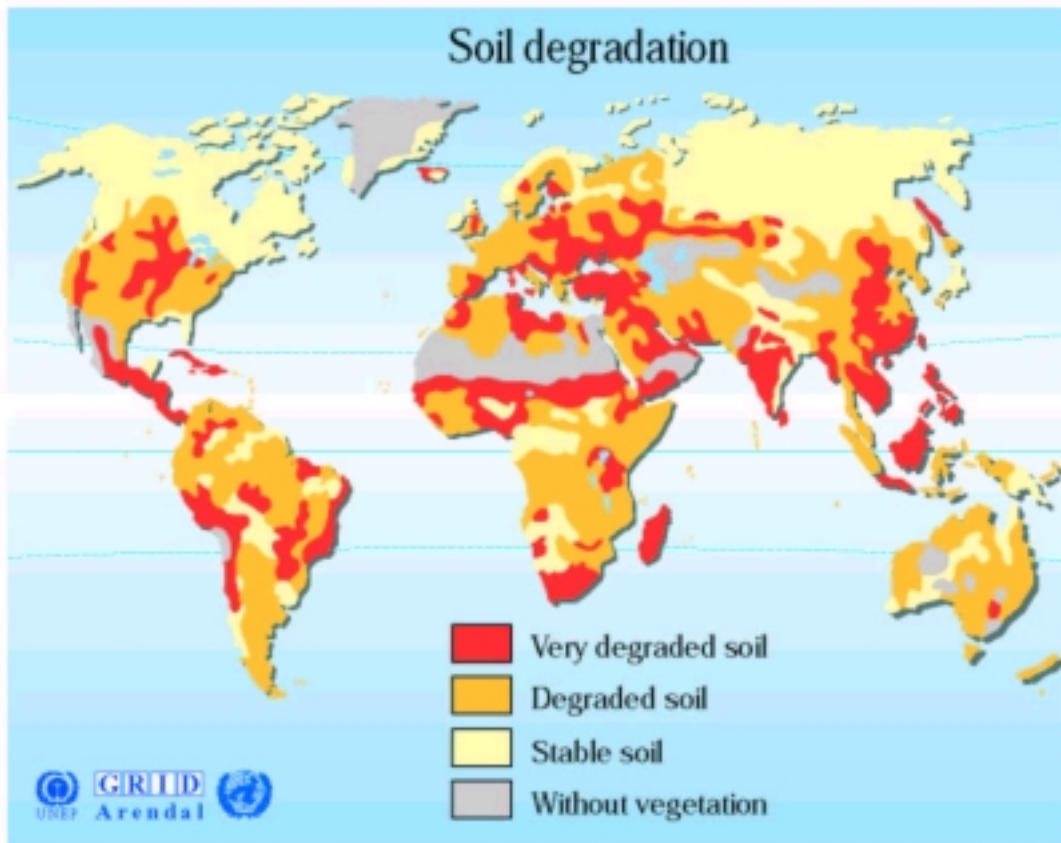


Figure 1 Distribution of degraded lands worldwide

degraded lands that require certain financial and technological investigation to recover, 74,400 km² are heavily degraded lands that need to be improved before being put into agricultural production, and 13,300 km² are severely degraded lands that are not suitable for agricultural production and can not be improved. The trend of land degradation is accelerated now, especially for the forest and wetland ecosystems, which causes an economic lost of up to 3.6 billion US\$ each year.

2 Case studies of ecological restoration in South China

2.1 Ecological effects of ecological restoration

Since as early as late 1950s in South China, we initiated several long-term projects for ecological restoration by setting up two ecological stations (Xiao Liang and Heshan). From the study results it is concluded that ecological restoration especially vegetation restoration bring about significant ecological effects of followings:

- * Erosion control (figure 2)
- * Environmental improvement (figure 3)

* Carbon storage increment

Based on 50-year observation data in the broadleaf mixed forest in Xiaoliang Tropical Forest Research Station where we have carried a long-term project of vegetation restoration since the end of 1950s. A regression equation of soil organic matter of the forest vs the time of restoration is established (figure 2). For the soil of barren land where our restoration project started in Xiaoliang, Guangdong Province, China, it needs about 148 years to restore the soil organic matter to the same level as it was in natural forest. Based on the soil bulk density (1.3g cm^{-3}), changes in soil organic carbon is represented in figure 4. Increase of soil organic carbon

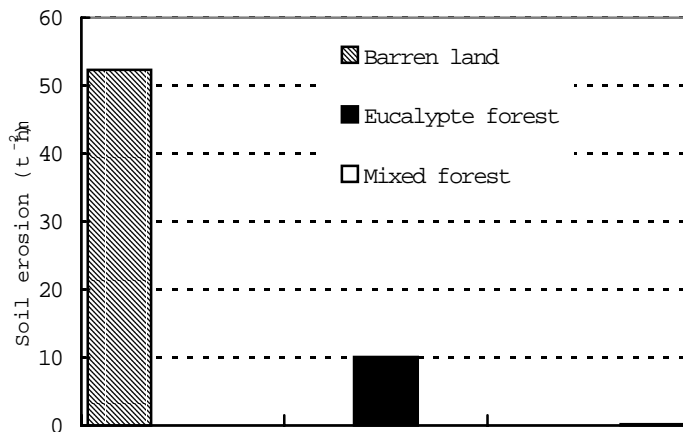


Figure 2 The erosion control of different types of ecosystems in Xiaoliang Station

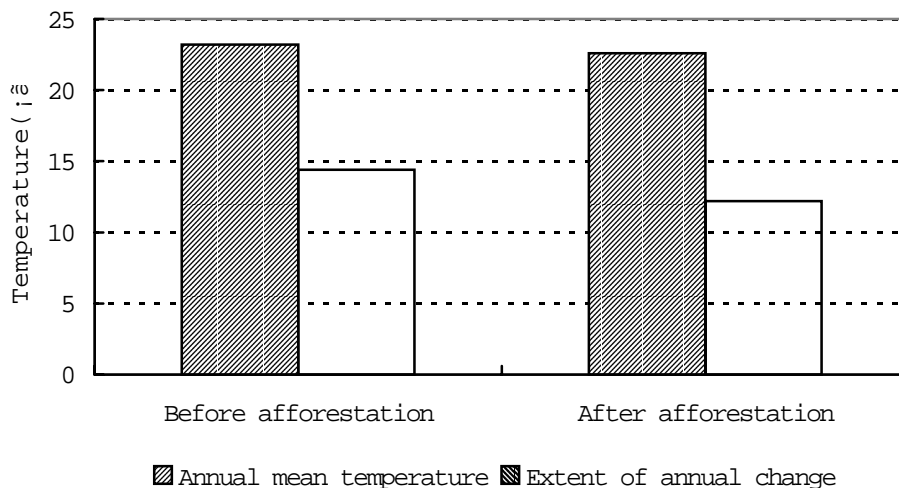


Figure 3 Temperature change before and after afforestation

means that more carbons enter into soil carbon pool. At the beginning time period (<50yr) of

vegetation restoration, soil organic carbon increased very rapidly. For example, about 50 kg C hm⁻² entered into the soil organic carbon pool after 50-year vegetation development, 90 kg C hm⁻² for 100 years, and 99 kg C hm⁻² for 150 years (figure 5). Expanding afforestation and forest protection

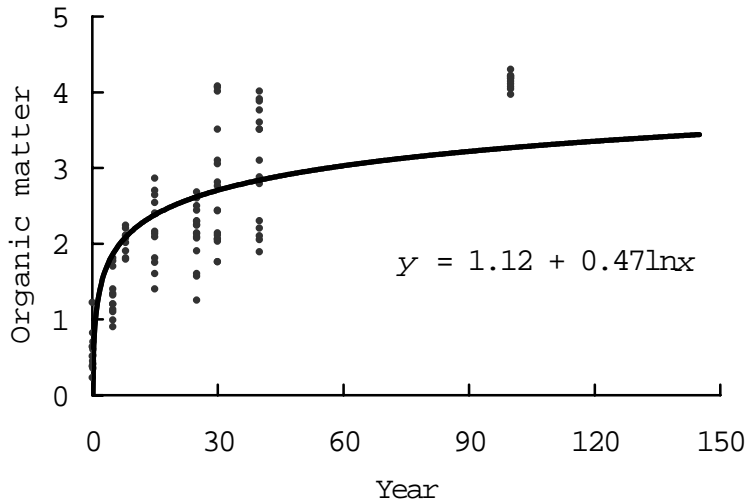


Figure 4 Regression curve of soil organic matter in the broadleaf mixed forest of XiaoLiang

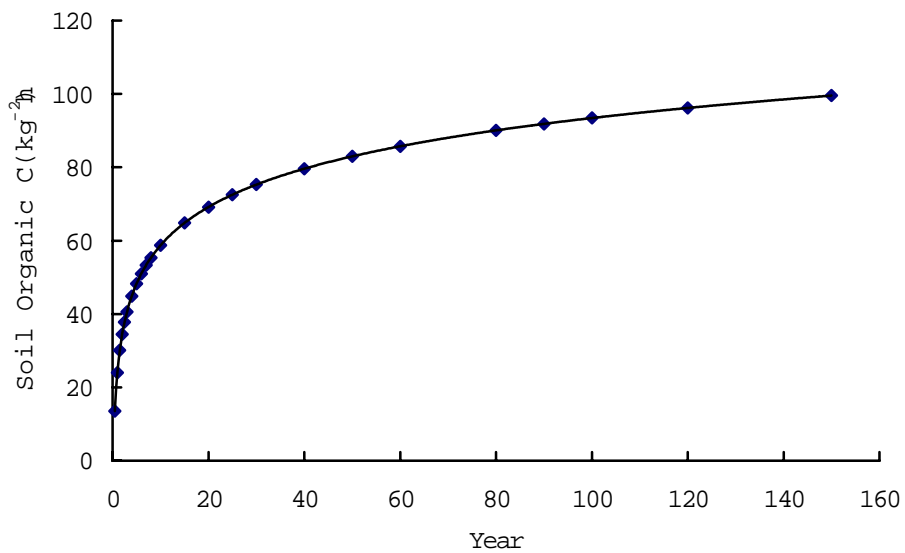


Figure 5 Soil organic carbon increases with the process of the broadleaf mixed forest development in Xiaolinag

are also able to increase the carbon storage in the soil (figure 6). From the long run, we can expect that further re-vegetation or construction of agroforestry ecosystems in the developing regions such as in South China where degraded lands have formed in large scale due to intensified social and economical activities of human will greatly contribute to the effort of reducing CO₂ enrichment in the regional atmosphere. From the figure 7 it is also indicated that different forms of land use affect the carbon storage.

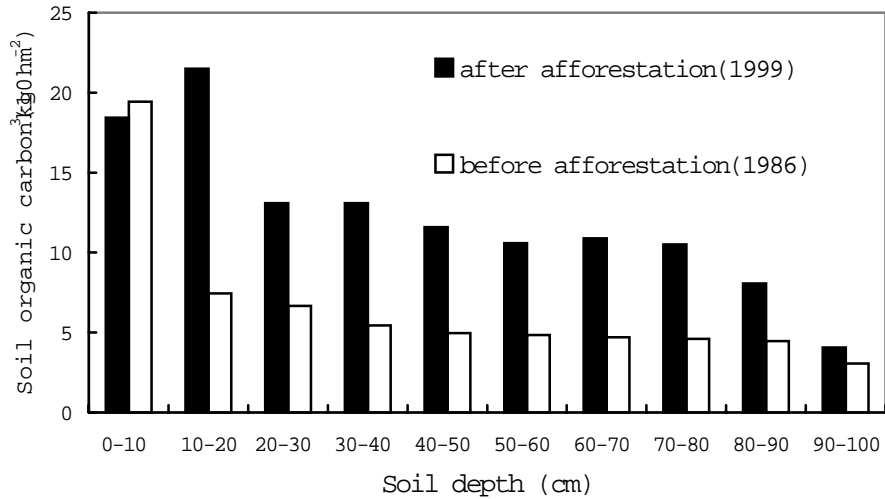


Figure 6 Variation tendency of soil organic carbon content in *Acacia mangium* forest sites

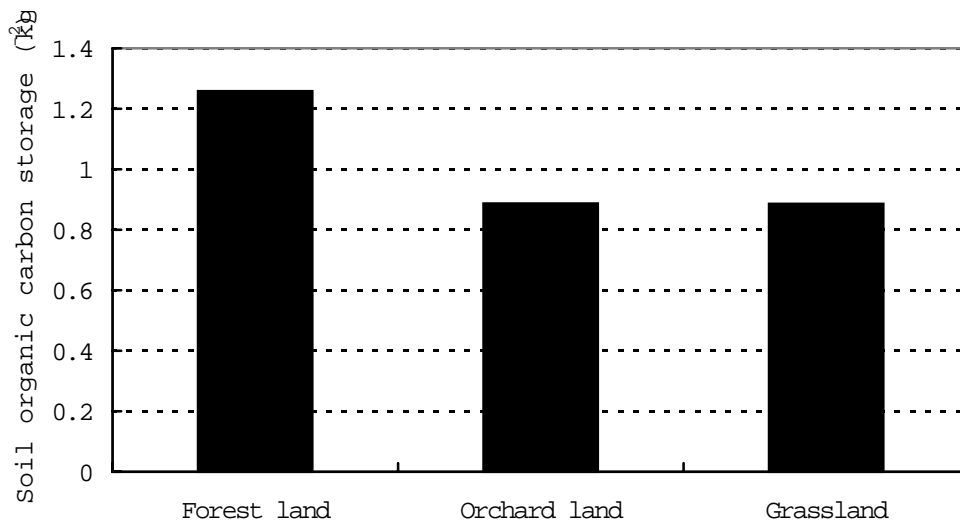


Figure 7 Carbon storage in soil of different land use

2.2 Economical effect of ecological restoration

Improved ecological environment would take effect in promoting agricultural production under favorable light, temperature and heat conditions in South China. That significant ecological effect was brought about together with obvious economic and social effects in the process of recovering degraded ecosystem in this zone, which was the common results obtained from all the restoration sites where we have practiced vegetation restoration (table 1).

Table 1 Economical effect through ecological restoration

Restoration sites	Location	Research demonstration	Demonstration area(hm ²)	Time length	Economical benefit(US\$)
Heshan Station	112°54'E 22°41'N	needle-broadleaf mixed forest, “forest-fruit-grass-fishery” agroforestry ecosystem	1.5×10^4	1984-1999	43.5 millions
Xiao Liang Station	110°54'E 21°27'N	man-made forest, economical crops	26	1959-1999	3 millions
Wu Hua Station	115°38'E 24°04'N	Restoration of natural secondary forest	23.5	Early 1980s-early 1999s	0.2 millions
De Qing Station	111°40'E 23°09'N	Restoration of natural secondary forest	3.8×10^4	Early 1980s-early 1999s	39 millions

3 Contribution of vegetation restoration to reducing global change

Our ecological restoration in the ecological stations for long-term studies serve effective demonstration in Guangdong Province, because most of the part of the province share common climatic, edaphic conditions and similar agriculture practice and land use. From 1986 to 1998 the vegetation coverage in Guangdong Province increased from 7.628×10^6 hm² to 10.113×10^6 hm², enhancing carbon storage from 8.12×10^8 t C to 12.94×10^8 t C. Roughly estimated, China produces 2.1×10^9 t CO₂ per year, namely 5.7×10^8 t C, and more than 1/10 of this amount emitted by Guangdong Province, about 5.7×10^7 t C annually. It can be estimated that the average carbon storage during that 12 years by increased vegetation of Guangdong is about 3.12×10^7 t C annually. The carbon stored by re-vegetation is more than half of that emitted into the atmosphere in Guangdong Province every year (figure 8, 9). Thus it may reduce the pressure of atmospheric CO₂ increase due to the global change. Therefore, ecological restoration of vegetation

is not only an effective way ensuring sustainable development of regional economical development, but also significantly contribute to buffering the pressure imposed by global change. As mentioned in the first section that China has degraded lands of 1,500,000 km² currently. We can expect that re-vegetation on these degraded lands as a possible huge carbon pool will present a great contribution in reducing global increment of CO₂ undoubtedly thinking that China ranks as the fourth among the top 15 CO₂ producing nations.

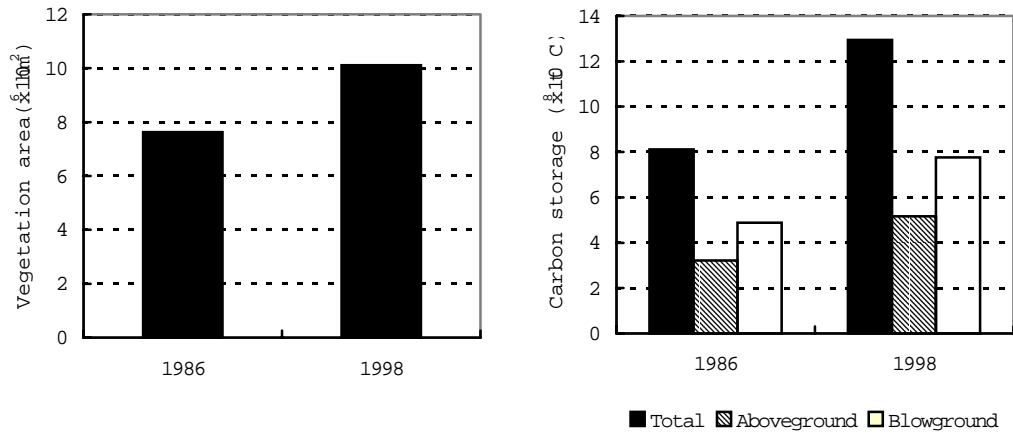


Figure 8 Vegetation area variation (left) and carbon storage in the vegetation of Guangdong Province

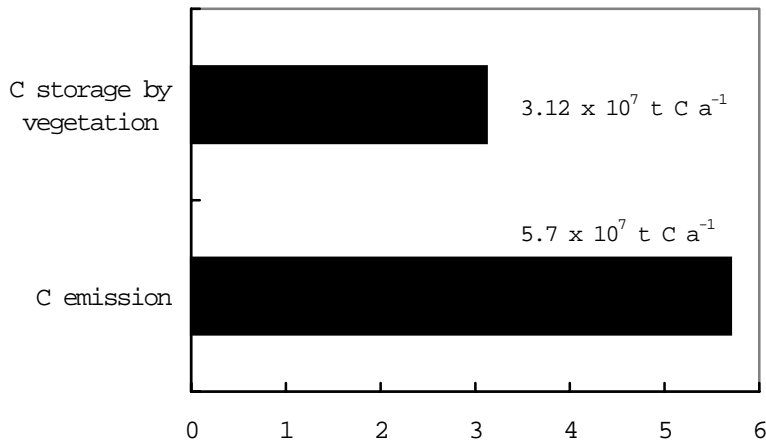


Figure 9 Annual carbon storage by vegetation and carbon emission in Guangdong Province