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Disadvantages and future research directions in valuation of ecosystem services in China

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SUMMARY

We have reviewed the development, background and valuation history of ecosystem services in China and abroad, and highlight the importance of ecosystem services and the necessity of their valuation at various temporal and spatial scales. Through critical review of the literature, we have elucidated disadvantages in studies of ecosystem services in China, including the lack of a definite purpose for the valuation of ecosystem services, improper emphasis of valuation studies, stifled application of the contingent valuation method, weak power of research panels in the field, and the absence of the participation of government officials. In addition, we discuss some case studies from Western countries which tracked changes in the total economic value (TEV) of ecosystem services across different states of ecological disturbance and evaluated changes in the TEV under different management regimes. These studies may be useful in guiding future research in China. In essence, there are three major aspects involved in the valuation of ecosystem services: improving accuracy of valuation, association of results of valuation with policy and management decisions, and transfer of payments for ecosystem services. We suggest three priorities for future research in China: to develop an ecosystem service valuation model, to enhance the relevance of valuation studies to policy development, and to reward the protectors of ecosystem services.

INTRODUCTION

Ecosystem services are explicitly defined as 'the natural environmental conditions and effects upon which people are relying for existence, which are formed and maintained by ecosystems and ecological processes' (de Groot *et al.* 2002). Since the explosion of the human population on Earth, the lack of awareness of ecosystem services and the lack of knowledge of their importance have led to over-exploitation of natural resources and damage to ecosystem services. As a result, the valuation of ecosystem goods and services has become an important issue in the field of environmental protection and sustainable development, with the final goal of raising awareness on the importance of ecosystem services for human life and production.

Origin and development of ecosystem service studies outside China

Studies of ecosystem services can be traced back to 1864, when George Marsh first proposed that ecosystems had the ability to provide services for

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human life and production. In his book *Man in Nature,* he suggested that elements, such as water, soil, animals and plants, are precious riches that have been bestowed on us by an almighty God. Moreover, he questioned and criticised the long-accepted view that the world's resources are infinite. However, because of the background of industrial production at that time, little attention was paid to his treatise. With the development of ecosystem concepts and theories in the 1970s, ecologists and economists, who examined ecosystem services from different perspectives, began to contemplate ecosystem services more seriously. Since then, 'ecosystem service' has become a scientific term, and the study of ecosystem services is now a branch of ecology and ecological economics.

In 1995, Heywood published *Global Biodiversity Assessment,* which was based on previous research. In 1997, the Ecological Society of America organized a panel led by Gretchen Daily to study ecosystem services systematically. The panel examined the concept of ecosystem services and assessed some important ecosystem types, such as forests, wetlands, grasslands and coastal areas. However, it was Robert Costanza who truly boosted ecosystem services to the frontiers of ecology; this was marked by his paper *The Value of the World's Ecosystem Services and Natural Capital.* In this paper, Costanza *et al.* (1997) classified global ecosystems into 16 types and evaluated 17 services performed by them, *viz.* gas regulation, climate regulation, disturbance regulation, water regulation, water supply, erosion control, sedimentation, formation of soil, nutrient cycling, waste disposal, pollination, biological control of pests and diseases, provision of refuges, food production, supply of raw materials, gene resources and entertainment and culture. Moreover, they accounted for the value of global ecosystem services as US$3.3 billion per year. Since then, many studies have been conducted in this field, and many of these serve to inform policy development and decision-making processes.

Origin and development of ecosystem service studies in China

From the time of reforms and the opening up of China in 1978, an open social system has become established. Consequently, the devotion of major efforts to the development of industry and the economy has resulted in the heightened seriousness of problems, such as resource shortages and environmental pollution. Thus, it is urgent to incorporate these ecological and environmental problems into the scope of economic development. In 1980, Dixin Xu, a well-known Chinese economist, was the first to launch studies on ecological economics, and for the first time, took into consideration the conjunction of ecological and economic factors. In 1984, Shijun Ma, a noted ecologist, associated the ecological environment with the economy in his article *Society–Economy–Nature aggregated ecosystem,* which marked the fact that Chinese ecologists had begun to set foot in the field of economics. In addition, based on theories and empirical research associated with ecosystem services in China and abroad, increasing numbers of Chinese scholars began to undertake research in this field. For example, Ouyang (1999) elucidated the terrestrial ecosystem services in China and assessed the total economic value of these services at RMB yuan 1.48×10^{14}. Moreover, he examined the implications of ecosystem services, valuation methods and the relevance of ecosystem services to sustainable development. Zhang *et al.* (2005) evaluated the total economic value of services performed by Chinese ecosystems in terms of Costanza *et al's.* (1997) parameters, including both terrestrial and marine ecosystems, at RMB yuan 77834.48×10^{8}, which was markedly different from the results of Ouyang (1999), likely due to differences in the valuation methods.

In addition to studies at a national scale, a wide range of regional-scale studies has been undertaken. For example, Xie *et al.* (2003) evaluated the economic value of ecosystem services on the Qinghai–Tibet plateau and concluded that the ratio of the values of goods to ecological services was 1:70. Thus, the value of ecological services is far higher than that of their direct use for the Qinghai–Tibet plateau.

DISADVANTAGES IN VALUATION OF ECOSYSTEM SERVICES IN CHINA

Incorrect purpose of valuation of ecosystem services

In recent years, although Chinese scholars have undertaken a wide range of valuation studies on ecosystem services in China (e.g. Ouyang *et al.* 1999; Zhang *et al.* 2005), the purpose of these studies remains ambiguous. Most studies evaluated the economic value of services performed by some types of ecosystems at the national or regional scale; however, they did not provide any guidelines for policy development. In addition, the valuation of ecosystem services was performed for static ecosystems, but dynamic changes in ecosystem services over time were not taken into account. In fact, the dynamic valuation of ecosystem services is the most important aid for policy makers in decisions involving ecosystem conservation and economic development. The original intention of the valuation of ecosystem services was not to put a 'price tag' on the environment or its components, but rather to express the effects of marginal changes in ecosystem services in terms of a trade-off against other things that people value (Hanley and Shogren 2002; Randall, 2002). Therefore, valuation studies of ecosystem services in China deviated from their primary purpose. Today, most valuation studies in Western countries focus on the application of their results to policy development, rather than on evaluating the valuation methods or their accuracy.

Incorrect emphasis of valuation studies

Thus far, most Chinese ecologists and economists in the valuation field have paid a great deal of attention to the methods of ecosystem services valuation, endeavouring to find more appropriate methods to value ecosystem services to produce more accurate results. However, ecological services cannot truly enter into the economic market with specific values because of their intrinsic characteristics. For a very long time, no attention was paid to ecosystem services, even though they exist. Because of serious ecological problems caused by pollution and over-exploitation of resources, nature's ecological functions are increasingly threatened. Under these circumstances, an awareness of the importance of ecosystem services and the necessity of conserving nature began to grow, resulting in the increasing popularity of valuation of ecosystem services. However, the economic values of ecosystem services are simply symbolic, and are relative rather than absolute values. The economic valuation of ecosystem services is only performed to facilitate the development of guidelines for policy and decision making. Consequently, researchers should spend less time and energy in increasing the accuracy of the economic value of ecological services; rather, they should strive to enhance the application of valuation studies to policy decisions.

Restricted application of the contingent valuation method in China

Until now, although ecosystem services valuation studies have been performed for several decades, only a few services can be valued economically via the combination of ecological and economic methods, e.g. carbon dioxide fixation, oxygen release, nutrient cycling, water and soil conservation, and water purification. The remaining services, e.g. recreation, culture and the provision of habitats for wildlife, must be valued by investigating people's willingness to pay for an increase, or to accept compensation for a decrease in these ecosystem services; this is the basis of the contingent valuation method (CVM). Although problems associated with the CVM, including biases in strategy, design, information, hypotheses and operations (e.g. Kahneman *et al.* 1991; Kahneman and Knetsch 1992; Diamond and Hausman 1994; Knetsch 1994; Zhang *et al.* 2005), have yet to be solved, CVM remains one of the most popular approaches for the valuation of nonmarket natural and environmental resources because of its simplicity and flexibility.

At present, CVM is extensively used to value ecosystem services in many Western countries. However, because of institutional and cultural differences from Western developed countries, the method has not been widely adopted by Chinese researchers. For example, in 2004, a simple personal survey of 100 people at the mid-literacy level was undertaken in Shandong Province, North China. One-quarter of these people had never realised that ecosystems could perform services, and 10 of 25 did not believe the concept or had no interest in knowing about it, even though investigators explained the concept to them in detail. Seventy people said that they knew a little about ecosystem services, and five people refused to answer any survey question. This phenomenon is partly a result of the indifference of the public toward the ecological environment and inadequate efforts of schools and governments toward environmental education of the public. Such a low public awareness of ecosystem services prevents the application of CVM in valuation studies. Thus, to popularise the method, the first step must be to improve public awareness of ecosystem services in China, which requires combined efforts of the public, the educational system, and the government.

Weak power of research panels in studies

Several studies of services performed by a wide range of global biomes indicate that ecosystem services have not only economic values, but also ecological and sociocultural values (Figure 1). Therefore, to evaluate ecosystem services, a series of ecological, economic and social aspects must be considered. Thus, the participation of ecologists, economists and sociologists is indispensable in ecosystem service valuation studies. Ecologists can identify the types of services and explain how ecosystems generate ecological services, economists can provide important ideas about valuation methods, and sociologists can present the sociocultural functions. If this type of study is performed by ecologists, economists or sociologists alone, the results and their relevance in policy development would be somewhat doubtful. Examination of the literature on ecosystem service valuation studies by experts in Western developed countries (e.g. Costanza *et al.* 1997; Turner *et al.* 2003) shows that most are the collective endeavours of ecologists, economists and sociologists. For example, the research panel in Costanza *et al.* (1997) consisted of 13 scholars; two of these were economists and the rest were ecologists and sociologists. However, most studies of ecosystem services in China have been performed by ecologists or economists alone. This has led to inaccurate valuation and analysis of the mechanisms involved in forming ecosystem services, and has also caused important sociocultural services to be ignored. Thus, studies of this type in China have far to go to meet the level of research in Western countries. Considering these flaws and the current state of the environment in China, research teams must recruit experts from a variety of fields to provide results that better serve policy development and management decisions.

Absence of participation by government officials

Originally, ecosystem services valuation studies were undertaken by researchers from many disciplines. However, because the fundamental goal of these studies is to provide guidelines for policy or decision makers, the participation of policy makers, i.e. government officials, is essential. However, very little ecological information from ecosystem services has been implemented through policy

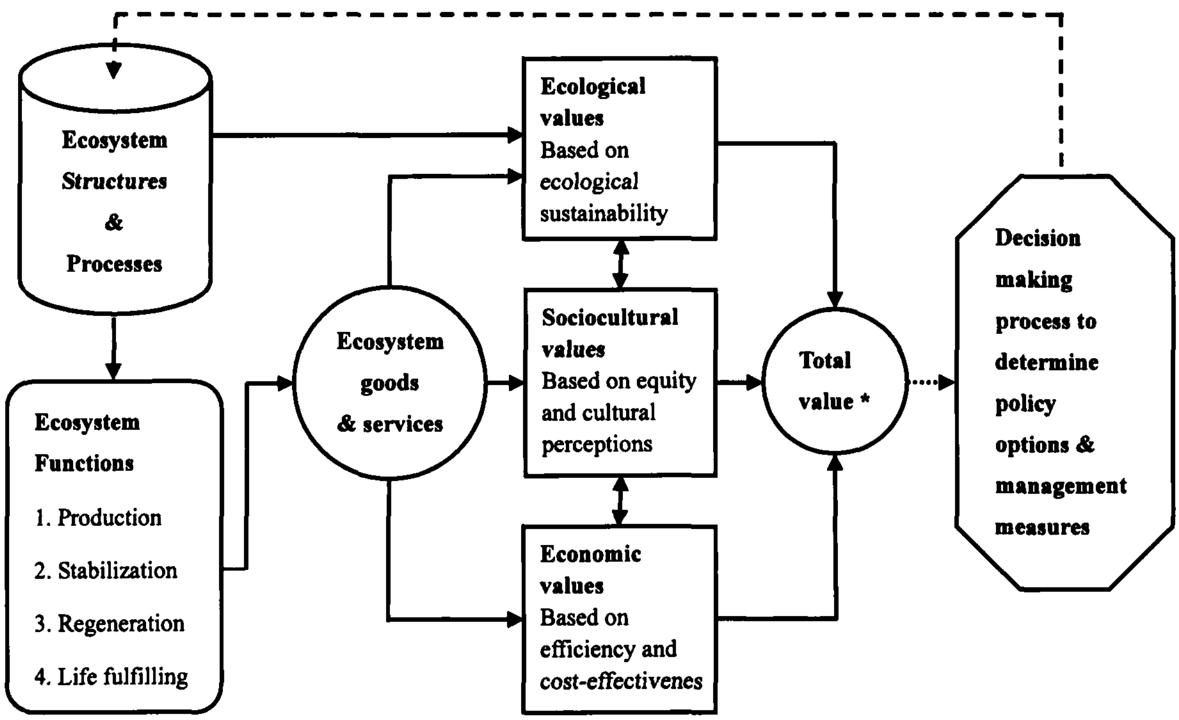

Figure 1 Framework for integrated assessment and valuation of ecosystem functions, goods, and services. Source: adapted from de Groot *et al.* (2002)

development in China. At the current high speed of economic development, studies of this type are increasingly critical for guiding policy makers in forming rational policies and management options. Moreover, after several years of efforts by experts worldwide, the quality of these studies is sound enough to provide scientific guidelines for policy makers. Therefore, ecosystem services valuation studies should advise government activities, rather than simple scientific activities. Before developing policies, policy makers should evaluate the marginal costs or benefits of alternative policies to formulate rational options. Consequently, policy makers must be provided with a full understanding of the economic potential of ecosystem services. However, studies associated with ecosystem services in China are currently simply scientific, with very little relevance to policy. There are many examples demonstrating that the lack of an understanding of ecosystem services by policy makers contributes to adverse effects on the environment and natural resources. In 2004, for example, in Hunan Province, a village leader had subordinates and the public cut down their forest and replant seedlings to obtain economic compensation fraudulently by returning 'cropland' to forest or grassland. Because of a lack of awareness regarding forest ecosystem services, the village leader sought to gain immediate rewards. Considering that it is necessary for government officials to understand all aspects of ecosystem services and their valuation methods, studies should be converted from simple scientific endeavours to include government activities.

CASE STUDIES FROM WESTERN COUNTRIES

Tracking changes in the total economic value across different states of ecological disturbance

A careful review of the valuation literature associated with Chinese ecosystem services shows that several studies have produced static estimates of the economic value of services performed by many types of ecosystem. Nevertheless, a few have attempted to track changes in ecosystem services across different states of ecological disturbance and evaluate the 'before' and 'after' value of ecosystem services (Turner *et al.* 2003). However, studies of this type have the highest relevance to policy and are an important aid for policy makers. This type of research is relatively advanced in developed Western countries, and there are many noteworthy examples. For example, Kreuter *et al.* (2001) used local satellite data to analyse the effect of changes in land use on dynamic change in the total economic value (TEV) of services delivered by six land-cover categories for the period 1976–1991 in the San Antonio area of Texas. They found a 65% decrease in the area of rangeland and a 29% increase in the area of urbanised land between 1976 and 1991, but there appeared to be only a 4% net decline in the estimated annual value of ecosystem services in the study area (i.e. US$5.58 ha^{-1} $year^{-1}$, with a 15-year cumulative total of US$6.24 million for the whole study area; Kreuter *et al.* 2001; Table 1). The analysis indicated that little economic value was lost because of a 403% increase in the area of woodland, which performed many ecological services and bore the highest economic value. Thus, based on changes in the value of ecosystem services, we might conclude that the ecological degradation associated with urbanisation was virtually nonexistent in San Antonio, and therefore, from an ecological perspective, urban expansion in the area was acceptable.

Evaluating changes in TEV under different management regimes

In recent years, many ecosystems in China have received tremendous pressure from the population explosion, agricultural development and industrial expansion. Therefore, prior to any attempt to develop policies concerning given ecosystems, it is necessary to compare and analyse the effects of different management alternatives from both economic and ecological perspectives to determine the most preferable policy. Our examination of the relevant literature shows that there are few examples in China that demonstrate good performance by policy makers to this end. Consequently, a greater effort is required to develop management regimes that are fully justified on both economic and ecological grounds. Some relevant experiences and lessons from Western countries can help to enlighten us. The following case studies would be helpful for future research in this field in China.

Mangrove is a major type of wetland that generates a wide variety of environmental goods and ecological services that are of great importance to

Table 1 Valuation of changes in ecosystem services with the loss of rangeland

Land-cover type	*Total area (ha)* 1976	1991	*Change in area 1976–1991 (ha)*	*Value coefficient 1994 ($ ha^{-1} yr^{-1})*[b]	*Change in value 1976–1991 ($ yr^{-1})*
Rangeland	80,497	27,896	–52,601	232	–14,187,931
Woodland	8886	44,654	35,768	302[c]	12,558,877
Bare soil	6353	13,047	6694	92[d]	715,996
Residential	11,499	16,655	5156	0[e]	0
Commercial	6116	15,362	9246	0[e]	0
Transportation	25,748	23,060	–1891	0[e]	0
Total	139,099	141,471	2372[a]	–	–913,058
Average loss of value ($ ha^{-1})					6.49

Adapted from Kreuter *et al.* (2001) and Turner *et al.* (2003), with permission.
[a]The change in the total area of these land-cover types between 1976 and 1991 indicates that lands other than those originally in the six categories were added to one or more of these categories. [b]The economic value coefficients of ecosystem services from Costanza *et al.* (1997). [c]Calculated using the value coefficient for temperate/boreal forest from Costanza *et al.* (1997). [d]Calculated using the value coefficient for cropland from Costanza *et al.* (1997). [e]The change in the economic value of these land-cover types was not evaluated

humans. However, because of the underestimation of their functions and values, at present, mangroves are under great development pressure from increased market integration and the world economy, especially those in the Philippines. Thus, to develop the most economically and ecologically efficient management regime, Gilbert and Janssen (1998) identified and analysed the goods and services generated by the Pagbilao mangroves, in the southern part of Quezon Province on Luzon Island in the Philippines. They assessed eight different management regimes and valued both the goods and the contribution of ecological services to the production of goods. The net annual value of goods provided by mangroves under preservation, i.e. 165,000 pesos ha^{-1}, was lowest over the short term, and 18,644,000 pesos lower than semi-intensive aquaculture. It is problematic if the large difference in the value of goods between these two management regimes can be eliminated by including the value of ecological services; however, because ecological services were not assessed economically (Table 2), the question could not be easily resolved. Unfortunately, based on a rough indication of the value of ecological services from other studies, Gilbert and Janssen (1998) concluded that semi-intensive aquaculture was the most desirable management option.

Although the previous example endeavored to evaluate eight different management regimes, the results were doubtful because no attempt was made to include the value of ecological services provided by the system. However, the following case study did consider ecological services.

In El Salvador, policy makers had to decide whether to convert mangroves to other land types to gain short-term benefits or to conserve mangroves to gain long-term benefits to meet the demands of an exploding population and expanding industry. Thus, Gammage (1997) evaluated the mangrove system under three management scenarios. Over the long term (approximately 60 years), the net current value of the sustainable management option reached $2344 ha^{-1}, the highest among the three management scenarios (Table 3), indicating that this was the economically superior option. This study demonstrates the importance of conserving natural ecosystems, and shows that long-term considerations should be included in policy development.

FUTURE RESEARCH DIRECTIONS FOR THE VALUATION OF ECOSYSTEM SERVICES IN CHINA

Whereas many efforts have been made in the valuation of ecosystem services and these studies are at a relatively mature stage in developed Western countries, such studies are still in their infancy in China. The major points that require emphasis are the methods of valuation, the application of research results, and mechanisms of providing

Table 2 Net annual value of goods and services under different the management alternatives A–H

	Unit	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Goods									
Fisheries	1000 pesos	165	161	161	124	8	8	40	40
Subsistence forestry	1000 pesos	0	349	0	0	0	0	0	189
Commercial forestry	1000 pesos	0	0	416	218	0	0	229	0
Aquaculture: fish	1000 pesos	0	0	0	5648	18,801	13,577	4992	4992
Mangrove nursery	0/+++	+	+	+	0	0	0	0	0
Total goods	1000 pesos	165	510	577	5990	18,809	13,585	5261	5221
Services									
Aquaculture: waste	0/+++	0	0	0	+	++	+++	++	++
Damage control	0/+++	+++	+++	+++	++	+	+	++	++
Ecotourism	0/+++	+++	++	0	0	0	0	0	+
Existence value	0/+++	+++	++	++	+	0	0	+	+
Information value	0/+++	+++	+++	++	+	0	0	+	+
Total services	0/+++	+++	+++	++	+	+	+	+	+

Source: Gilbert and Janssen (1998), with permission.
A, Preservation: no extraction of forest products (e.g., wood, nipa shingles, biotic resources for medicines) is allowed; gathering of gastropods and crabs is allowed. B, Subsistence forestry: extraction of forest products such as fuelwood, charcoal, and poles for fences and posts by coastal communities is allowed. C, Commercial forestry: exploitation of mangroves is allowed. D, Aquasilviculture: excluding a buffer zone, conversion of about one-third of mangrove forests to fishing ponds, and maintenance of the remaining mangroves within the ponds. E, Semi-intensive aquaculture: conversion of the mangrove forests to fishponds and their water distribution system, with the remaining mangroves in a buffer zone. F, Intensive aquaculture: conversion of the mangrove forests to fishponds, with intense management of the ponds, i.e., higher cropping density, more frequent cropping, greater use of food supplements and chemicals. G, Commercial forestry/intensive aquaculture: excluding a buffer zone, conversion of about one-third of mangrove forests to fishponds for intensive aquaculture; exploitation of the remainder of mangrove forests for commercial forestry. H, Subsistence forestry/intensive aquaculture: similar to G, except exploitation of the remaining forests, excluding the buffer zone, for subsistence forestry in a sustainable manner.
Contribution to value: +++, large; ++, moderate; +, small; 0, none

rewards for ecosystem services, which have long engaged researchers in this field.

Currently, Chinese researchers assess the economic value of ecosystem services with long-used economic methods, such as the market value technique, the substitution engineering method, the shadow price method, etc., or using Constanza *et al's.* (1997) economic coefficients of ecosystem services with relevant corrections. However, although much time and energy is spent to obtain the economic value of ecosystem services, the results are not highly accurate. To solve these complicated problems in complex systems, the development of valuation models is necessary. The first step in developing a valuation model is to establish an indicator system of comprehensive evaluation for ecosystem services. Generally, such an indicator system is composed of three layers. First, because of the interdependency of ecosystem services, they are simply classified into two types: direct production services and ecological services. Second, ecological, social, and economic factors that are critical to ecosystem services are determined. Third, indicators used to measure the above factors are identified. These three layers are the service, factor, and indicator layers (see agroecosystem example in Table 4). The second step is to determine the quantitative relationship between services and their indicators, which is the most difficult and important part of this task. To evaluate the services performed by a given ecosystem, a large number of experiments are required to obtain the attributes of that ecosystem.

Currently, the most pressing problem in ecosystem services valuation studies in China is the lack of relevance to policy development. Therefore, future emphasis should be placed on the assessment of alternative policies through the analysis of changes in the value of ecosystem services. There are many recent projects in China, such as

Table 3 Net present value of different management scenarios, 1994–2050[a]

	Management option value ($ ha^{-1})[b]		
Goods/services	*Current management strategy*[e]	*Partial mangrove conversion*[f]	*Sustainable management option*[g]
Clearance logging		58	
Fuelwood and timber[c]	18	11	25
Artisanal shrimp and fish	755	736	800
Industrial shrimp[d]	902	761	1516
Rustic salt and shrimp	3		3
Shrimp ponds		91	
Total	1678	1657	2344

Source: Turner (2003), adapted from Gammage (1997), with permission.
[a]Assuming a discount rate of 7.08%.
[b]Given a total mangrove area of 487 ha.
[c]Costs and benefits were calculated assuming that all timber needs would be met and that fuelwood consumption would be determined by the remainder.
[d]All fisheries benefits are the net of primary producer costs; all capital is amortized over its lifetime and discounted at the cost of borrowing.
[e]Under the current management strategy, deforestation and land clearance are allowed.
[f]In the partial mangrove conversion scenario, it is assumed that 240 ha will be converted to shrimp ponds and the remaining mangrove depleted for community timber and fuelwood.
[g]In the sustainable management scenario, it is assumed that only mature trees are felled

Table 4 The indicator system of comprehensive evaluation of agroecosystem services

Service layer	*Factor layer*	*Indicator layer*
Direct production	Net photosynthetic capacity	Mean annual net primary production (NPP, kg ha^{-1}); cost-corrected NPP (kg ha^{-1})
	Soil fertility	Average decrease in soil organic carbon; estimated yield loss caused by changes in soil structure and physical quality; soil loss caused by wind erosion; potential risk for impairment of soil biological activity because of heavy metals; total wheat yield in years with above the critical concentration of cadmium (%)
	Maintenance of water quality and quantity	Potential risk of pesticide residues in surface waters in the agricultural landscape (%); percentage of all shallow drinking water wells exceeding 22.1 mg NO_3 L^{-1}; changes in water retention and ground water levels in the landscape
	Nutrient supply	Kilogram of nitrogen fertilizer applied per kilogram of nitrogen in the harvest; nitrate leaching (kg ha^{-1})
Ecological service	Ecological carrying capacity	Increase in field size; reduction in small uncultivated biotopes
	Maintenance of biological and genetic information	Vascular plants extinct since 1950 (% of total extinct in the agricultural landscape); endangered species in the agricultural landscape (% of total endangered)
	Biotic regulation	Presence of wild pollinators and their estimated decline in regions with intensive agriculture; estimated decrease in the abundance of cereal invertebrates
	Contribution to global climate regulation	Total emissions in carbon dioxide equivalents (kg ha^{-1})

Adapted from Björklund *et al.* (1999)

"Conversion of Cropland into Forest or Grassland," "North–South Water Diversion," and "Three Gorges Project," which are closely related to human production and survival, and ecology. Because of the importance of these well-known projects, it is necessary to evaluate their marginal costs and benefits. In addition, whereas policy makers develop policies for a given region, ecosystem services valuation should examine the trade-off between the net benefits of conservation versus those of development at various scales. Thus, scientific research should be incorporated into the process of policy development.

Although the benefits of environmental services are widely distributed, most beneficiaries do not pay for the services; rather, the conservation costs are usually borne by the "service protectors" that live on the hillsides and mountains that cover most of China. The service protectors, who account for 92% of the poverty-stricken population in China, lead hard lives, with no income from the protection of these ecological services. Thus, reward mechanisms for ecosystem services are necessary to alleviate human poverty in areas rich in natural resources. In recent years, many programs have been undertaken to reward service protectors throughout the world. Even though the majority of these programs were designed to protect natural resources, rather than to alleviate poverty, they have aided people financially to some extent. Nevertheless, a few programs were developed to compensate the poor for the protection of ecosystem services. For example, an innovative program committed to improving the standard of living of the upland poor has been implemented in Asia: RUPES, "Rewarding the Upland Poor for Environmental Services They Provide." The core of the RUPES strategy is to test a range of methods by which beneficiaries of ecosystem services can pay upland communities for their environmental stewardship. However, China has not yet taken part in the program. Thus, we should make every effort to develop payment mechanisms for ecosystem services and reward the poor that protect the ecosystem services to help these people lead a better life and prevent natural resources from further damage and overexploitation.

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