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The key problems and future direction of ecosystem services research

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Abstract

The article discusses on the key problems and the trends of future direction of ecosystem service research. First it reviews the achievements of ecosystem service research, then summarizes the present situation of research of ecosystem service in China, pointing out the main existing problems in value appraisal of ecology service: Ecology service value is measured by simple quantification and double counted; The same appraisal system are applied to different regions and different scales; static method is used to appraise dynamic ecosystem. It holds that the evaluation model in ecosystem service research is not very reasonable, and the method of substitution somewhat farfetched; that subjective factors influence the measure results; ecology compensation research lags back;and the research lacks driving factors analysis of ecology service function and study on service function forecast and early warning model; and that the researches do not connect ecology service value appraisal with ecological security research. Finally, the article points out the future direction of research

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1. Review of ecosystem services research

1.1. Differentiation of related concepts of ecosystem service : Ecosystem services and ecological function, status evaluation and function evaluation of ecosystem

Ecosystem services refer to the benefits taken directly or indirectly from ecological system, including input of useful material and energy to the economic and social system, acception and transformation of

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wastes from the economic and social system or direct provision of service to human society. The term of ecosystem originated in middle-late 1960s^[1]. The concept of ecosystem services was put forward by the UN University in 1970 in the report of “the Influence of Human on Global Environment”^[2].

Ecosystem function are processes and conditions provided by natural ecological system and its species that can meet the needs of human’ living. Ecosystem service functions containing natural capital flow, logistics, and information flow together with the non-natural capital produce human’s welfare^[3]. In 2003, on the basis of previous work, the Millennium Ecosystem Assessment (MA)^[4] divided ecosystem services into four categories: supply service, regulating service, cultural service and support services^[5]. On the basis of summary of every service and function, it explicated the relationship between the services, and this classification is widely acknowledged.

Ecological service value is the ecosystem services provided by the ecosystem that can be quantified. The ecosystem services value can be divided into natural asset value and humanistic value two parts^[4]. From the perspective of utilities, ecological services value can be divided into utility value and non-utility value, the former includes three parts: directly use value, indirect value (ecological value) and optional value (potential value), or include heritage value and existential value^[6]. De Groot^[7] generally divided the ecosystem service value into three parts according to the influence on human welfare: ecological value, social value and economic value.

Ecological functions is the inherent characteristics of series of state and process of ecological system to maintain its integrity (such as primary productivity, food cycle and biogeochemical cycles), including decomposition, production, nutrient cycling and transfer of nutrient to energy flux that build physiological function of organisms within the system^[6], and is the basis of ecosystem services. Ecosystem service is produced by its functions, being a kind of satisfaction of ecosystem function to human welfare, and is defined from the perspective of human welfare. The concept would change with the development of human society and human beings and variation of regions and cultures.

1.2. Ecosystem service classification

The Millennium Ecosystem Assessment (MA) took ecosystem service function and its evaluation as one of their main research tasks. Costanza^[4] estimated the annual service values of all types of ecological systems in the world. In 1997, Daily-led research team published a book named Nature service: Societal dependence on Natural ecosystem^[8], introducing the concept and connotation of ecological service function, methods and principles of value assessment and gave some case studies at the first time. Environmental committee of the International Federation of Science^[4] established a research group led by Costanza. Robert. They studied on the relationship between biodiversity and function of ecosystem services, the first time evaluated the value of global ecological service function and illustrated the service function and production function^{[9][10]}. Many studies have adopted this evaluation method.

1.3. The assessment of ecological services value

In 1970 United Nations University published a report of human’s impact on global environment the first time put forward the concept of ecological system service, and enumerated the service function of environment to human^[11] and then Holder^[12] and Odum^[13] carried out early influential research^[14]. In 1991, Environmental Committee of the International Federation of Science launched a conference discussing the quantitative evaluation of biodiversity, promoting the study of the relationship between biodiversity and ecosystem service function and its economic value evaluation method. Then research and exploration on biodiversity and ecosystem service value evaluation increased gradually and formed an important branch of ecological economics research and were applied in different scales and different types

of ecosystem value assessment, becoming the focus of ecology research. Costanza studied the evaluation of the main types of global ecosystem services^[14], uncovering the prelude of study on the ecosystem services value^[13]. From then on many countries have carried out this kind of research work with a lot of practices, and obtained a certain results..

The introduction of ecological service value into China in the 1990s caused much attention from Chinese ecologists, ecological economists, etc. Based on the method put forward by Costanza, Xie gaodi^[15] revised the value of ecosystem services through the biomass of grass land. Ouyangzhiyun^[16], using shadow price method and alternative method of engineering or method of profits and losses, analyzed and calculated the main value of ecosystem service function of China's land, including the grass land . JiangYanLing^[17] etc estimated the value of services of forest ecosystem in China.

As for methods of ecosystems services assessment, at present, most are based on market and on the basis of market prices of basic unit to measure the value evaluation. According to the development level of market, ecosystem services can be divided into three categories^[18]: realistic market; agent market and simulating market. In comparison, realistic evaluation method is based on an actual market, the agent market and the simulating market have certain subjectivity, and somewhat far-fetched, being subject to the influence of the estimator and region of evaluation and assessment and social development degree^[7].

1.4. Assessment scale of ecosystems services

The scale of ecosystem services can be space (spatial), also can be the time (temporal). Current research mainly focuses on space scale. Most of their study periods are 10-20 years, and belong to static research or comparative study of two time points. From the global ecosystem evaluation space scale, ecosystem services can be divided into global or regional scale, watershed scales, single ecosystems and species scale four types^[13]. Currently basin scale and single ecosystem are the main scale and there is the tendency from macro scale to micro scale.

2. The main problems existing in the research of ecological service value evaluation

2.1. Lack of innovation and practicability, ecological service value is simply quantified and repeatedly calculated

Simple linear add of service value of these function cannot reflect the relation and integrity between them, and producing the problems of repeated computation. Lack of understanding of the interrelationship between the ecosystem services evaluated and the products for marketization, the credibility of the evaluation result needs qualification^{[19][20]}. The key of common-used market substitute method in evaluation is to precisely define the characteristics of the replaced ecosystem^[21], and the elements replacing and being replaced must be completely equivalent^[19]. At the same time, the application of the model must consider the differences of parameters between regions.

2.2. Lack of time dimension research , evaluate dynamic ecosystem with static evaluation method

There are more isolated, static researches, less dynamic, systematic study. Ecological system is complex and dynamic; and the life cycle of ecological system is in a succession of evolution sequence. Time and space are important variables of the ecosystem services value. In time and space scale, the relation between all parts is often nonlinear, making the supply level of ecosystem unpredictable^[22].

2.3. Subjective factors influence the evaluation results

For the market of virtual scene, when using the common used contingent valuation method, the behavior of evaluation is not based on the real market behavior. Information provided by questionnaire and the order of problems put forward and the understanding extent of the answerers to the questions will influence the evaluation results. It will also be influenced by the role of value rule, as well as consumer's preferences (respondents' preferences, the humanities, and environmental awareness will have an important impact on evaluation results) to produce deviation. The quality of researcher, research methods, the concept, theory, model and the weighing values can also lead to different results.

2.4. Few research results are transferred to policy and practical application, research of ecological compensation lags behind

Due to lack of uniform standard, regional differences and the individual factors of estimator the research results of ecosystem services cannot be compared and dynamically studied. Most research results are just confined to academic discussion, have yet been recognized by the public and the government, less has been used for policy making. Domestically ecological compensation study focuses on concept theory research, design patterns research of policy and compensation standard, lack of study on the space-time distribution, standard level division of compensation and implementation method, bringing difficulty to policy application.

2.5. Lack of study on driving factor of ecological service and forecast and warning model of service function, lack necessary connection of the ecosystem services value evaluation with ecological security research

3. Future directions for study

In present, research of ecological services is significant. It is a beneficial supplement to traditional development mode and resource allocation under the ecological, social and economic multiple targets, promoting the healthy development of ecological industry and protection and utilization of ecological assets, management and optimization of the ecosystem, conduce to improve the social harmony and the people's ecological consciousness, and is a powerful guarantee for promoting construction of resources-conservation and environment-friendly society and low carbon economy transformation. In future years, ecological service research should progress in the following aspects: (1) study on response of ecological services under the condition of human intervention. (2) Research in ecological service artificial ecosystems. (3) study on mineral exploitation, land reclamation and ecology benefit evaluation of vegetation restoration and trans-regional and trans-production compensation mode and research on stakeholders' compensation will, (4) study on social economic and environmental effects, such as poverty, regional gap, species diversity, etc. (6) study on ecological restoration and profit evaluation research (7) dynamic evaluation of ecological services, simulation research and ecological safety warning research (8) study on the basic theoretical research and the localization of model and index. (9) Study on the relationship between ecological service function and structure and between the elements of ecosystem and research on ecosystemservice function driver. (10) Research in ecological assets loss.

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