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ECOLOGICAL PREREQUISITES FOR SUSTAINABLE ECONOMIC DEVELOPMENT AND CONSERVATION OF NATURAL RESOURCES

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自然资源保护和经济持续发展的必要生态条件 Frank McCormick（美国田纳西大学生态学教授，中国江苏省植物研究所名誉研究员）植物资源与环境 1992,1(2): 43～49

本文系统而扼要地论述了在自然资源保护和经济持续发展中，生态学方面的先决条件。人类活动造成了环境的日益恶化，并威胁着生物圈。第三世界国家必须发展经济，否则，贫穷、饥饿和疾病将危及整个民族的生存，现行的环境持续发展的概念也许只是掩饰矛盾而并不现实。因此必须用新的战略决策使经济增长居于稳定的生态环境之中。如果把生态学原理、方法和现有的知识有效地贯彻到经济计划中，经济的持续发展就会变成现实。发展中国家试图取得经济的持续发展，必须注意以下 10 个必要生态条件：1. 信息的传播。信息传播包括环境科学专业化训练、公众环境知识教育及有关发展计划和决策的生态学概念的诸多内容。应让决策者了解生态学理论基础；2. 讲习生态系统知识。制定经济发展计划时必须认清生态系统内部、生态系统之间的相互作用，建立生态系统的概念模型以说明生态系统各组分之间的相互依赖关系；3. 必须认识到生态、经济、政治和社会系统间的相互联系，人类及其社会系统是关键所在；4. 设计生态系统的经济模型，为决策者提供自然资源的有关信息；5. 使自然资源从消耗性利用向非消耗性利用转变；6. 加强和下放权力，强制执行环境政策和法规；7. 简化有关环境法规，开明地应用环境评价方法。政策与法规不应当超出政府的能力范围，并考虑当地民众的理解力；8. 自然资源目录和人口统计信息；9. 政治和经济的实际状况，科学家常忽视其重要性。环境保护及其持续发展的最佳途径，是将环境政策纳入政府现有的法规；10. 公众参予决策，这样才能为公众所理解并能确保其持续发展，这也许是最重要的生态学前提。

关键词 自然资源保护；经济发展；生态条件

Key words conservation of natural resources; economic development; ecological prerequisites

Sustainable development requires development practices which do not degrade target ecosystems, which require minimal subsidies to maintain ecosystem productivity, and limits upon consumption of ecosystems goods and services which fall within carrying capacities. The following quotes attest to the seriousness of the quest for sustainable development.

1. "Environmental problems resulting from human activities have begun to threaten the earth's

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life support systems." The Sustainable Biosphere Initiative (SBI) (Ecological Society of America 1991).

2. From the SBI we go to the SEI, Sustainable Environmental Initiative proposed by U. S. Senator Albert Gore soon after his candidacy for President of the United States (Gore 1989). "The Third World does not have a choice about whether or not it will develop economically. If it does not develop economically, poverty, hunger and disease will consume entire populations. And long before that, whole societies will experience revolutionary political disorder. Rapid economic growth is a life or death imperative throughout the Third World. The peoples and governments of the Third World will not be denied that hope, no matter the longer term costs for the global environment." "This central fact cuts across the face of all environmental strategies as we generally think of them. It suggests that the notion of environmentally sustainable development at present may be an oxymoron, rather than a realistic objective. It declares war, in effect, on routine life in the advanced industrial societies. And——central to the outcome of the entire struggle to restore environmental balance——it declares war on the Third World". "The cross-cut between the imperatives of growth and the imperatives of environmental management, represents a supreme test for modern industrial civilization. The test is whether we can devise very dynamic new strategies which will accommodate economic growth within a stabilized environmental framework". "To deal with the global environment we will need the equivalent of the Strategic Defense Initiative, a Strategic Environmental Initiative."

3. "When policies of sustainable development are followed, our economic and our environmental objectives are achieved." U. S. Secretary of State James Baker, Febuary 26, 1990.

4. The most profound quote is from the President of Rwanda (McCormick 1983). "If, in the struggle for economic development and survival, we jeopardize the sustained productivity of our natural resources, the struggle will have been in vain." The struggle need not be in vain, sustainable development is a realistic goal if principles, methods, and existing knowledge of ecological science are effectively applied to development planning. Decision makers in developing countries (DC's) and in international institutions working with DC's are beginning to accept sustainable development as a realistic and desirable alternative to short term economic development. However they are not convinced that more and better ecological research, such as that proposed in the SBI, is the most limiting factor to achieving environmentally sound and sustainable economic development. And neither am I! In eastern Europe, Africa, Central and South America and Asia the most urgent appeal is to share what we already know, and then later, together, we shall learn more thru cooperative research. The remainder of this paper is a description of 10 ecological prerequisites to achieving sustainable development in DC's.

(1) The first of 10 prerequisites and the most serious constraint to achieving sustainable development, is information transfer. Information transfer includes professional environmental training, public environmental education and inclusion of ecological concepts and knowledge in development planning and decision making. We can move furthest and fastest toward achieving sustainable development by giving top priority to the transfer of existing ecological knowledge to

decision makers who determine international, national, regional and local policies. Policies guide actions and actions cause impacts. Existing ecological knowledge can provide the rationale for policy reforms which minimize environmental impacts, achieve sustainable development, and insure that the Third World struggle for survival is not in vain. Identifying information transfer as the first and foremost prerequisite to environmentally sound and sustainable development is identifying the education component of the SBI trilogy (Fig. 1) as the component with the greatest potential for achieving success. One significant form of information transfer is thru bilateral and multilateral programs of education and research. During the past decade Chinese ecologists have learned a great deal about recent advances in western ecology, including population dynamics, landscape ecology and ecosystem simulation models. Thru these exchanges western ecologists have learned from Chinese ecologists the benefits of truly interdisciplinary research and of significant advances in restoration of degraded ecosystems. Chinese ecologists routinely integrate theoretical, experimental, descriptive and applied ecology so that results of the most basic research are rapidly applied to agriculture, medicine, resource management and environmental protection (Zhao 1990). Reclamation of deserts (Zhu and Liu 1983) and reforestation projects employ methods and achieve results seldom experienced in the west.

(2) A second prerequisite, a lesson from ecosystem science, is that in development planning we must recognize the importance of interdependencies within and between ecological systems. Development planning should begin with a conceptual model of the ecosystems to be affected. Ecosystem models illustrate interdependencies and interconnectances of components within ecosystems. Interdependencies, such as the transfer of energy or matter between components, are often more fragile or of greater ecological significance than are individual components. Flows and cycles within and among ecosystems often result in the transfer of negative impacts of development actions to ecological targets far removed from direct or immediate actions. If we are to effectively manage interdependencies between ecosystem components the structure of management systems should mimic the structure of the systems being managed. Interdependent ecosystem components such as people, water, wildlife, fish and forests must be represented by decision makers who are equally interactive and interdependent. This approach to environmental decision making has been especially well developed by "The Project on Structure and Function of Main Ecosystems in China and Demonstration of Their Optimum Managerial Models" by the Chinese Environmental Research Network (Zhao 1989).

(3) The third prerequisite is an expansion of the second. In development planning we must also acknowledge the interdependence of ecological, economic, political and social systems (Fig. 2). Sustainability is the goal of every political system. Political stability is dependent upon sustained economic productivity. Recent events in eastern Europe make this abundantly clear. It is not sufficiently acknowledged that sustained economic productivity is dependent upon sustained ecological productivity, whether in agrarian or industrial societies. There is growing awareness of interdependencies between the productivity and sustainablilty of ecological and political systems.

Today, the worlds natural resources are shared resources, irrespective of the country in which they reside. foreign policies and military actions are shaped by national demands for international resources. Today the demand may be for oil or available land, tomorrow the demand may be for clean air or water. The peoples of the world and their social systems (Fig. 2) are centermost in terms of being the causes, and suffering the consequences of changing interdependencies between ecological, economic and political systems. No one contributed more to the understanding of these interdependencies than did the late Professor Ma Shi-Jun, who established the Ecological Society of China in 1979 and more recently helped to establish the Society of Ecological Economics of China (Liu 1991). U.S. Senator Albert Gore (Gore 1989) presents a startling message to the world: One benefit of growing peace among the super powers is that concern for environmental quality and sustained productivity of natural resources now rivals national security as the primary rationale for foreign policy.

(4) The prerequisite most germane to the emerging discipline of ecological economics is the need to develop economic models of ecological systems. If the true and total economic values of ecosystem goods and services are accounted for, economics alone will often justify sustainable development policies and practices. Decision makers cannot be expected to assimilate complex arguments involving ethics, intrinsic values or the tragedy of the commons. At best they can comprehend an ill defined economic value or a single numerical value from an environmental quality index. Economic models will provide decision makers natural resource information in a form they can understand. Development of economic models of ecological systems can be a major contribution of the emerging discipline of ecological economics. Figure 3 illustrates a simplistic model of interactions between ecologists and economists which can contribute to the goal of sustainable development. In China, the right hand pathway to sustainable development may best be represented by the thoughts and writings of Professor Ma Shi-Jun. A good example of the left hand pathway is the ecological engineering of wetland ecosystems at Maanshan steel mill by Jiangsu Institute of Botany. The central pathway is the central business of the Environmental Protection Agency of China which employs the environmental impact assessment process (Fig. 4) in its efforts to achieve sustainable development.

(5) Another ecological prerequisite is a shift from consumptive to non consumptive uses of natural resources. The extractive reserve experiment in the Amazon of Brazil (Fearnside 1989) is a good example of non consumptive use of natural resources. This promising experiment deserves time, support and rigorous comparison with economic and ecological alternatives. Agroforestry and harvest of non-timber forest products are non-consumptive uses of resources within these reserves. Ecotourism is rapidly growing and can be a highly successful non-consumptive use of rare and scenic resources. In China, as economic conditions have improved significantly during the past decade unprecedented numbers of Chinese are visiting scenic areas of natural beauty. Properly managed, increased tourism can contribute to protection of these national treasures. If not well managed, increased tourism may destroy the national beauty of China. Tourism which does not violate ecological guidelines (Forem 1990) and which does generate income for local people and for local conservation, provides us with

some of our greatest success stories in sustainable development (Aveling 1981).

(6) An important prerequisite to sustainable development in many DC's is stronger and more decentralized enforcement of environmental polices and regulations. In the eastern province of Kenya the Provincial Commissioner recently acknowledged the value of ecological research and environmental training (University of Tennessee 1982) but made it clear, environmental protection first requires guns and petrol. Without enforcement little else matters. In the Amazon of Brazil there exist magnificent biological reserves, at least in the minds of those who have never been there. In reality there may be no guards, no boundaries and no restrictions. A similar problem occurred at the Wolong Reserve in Sichuan Province of China. If top priority is not given to enforcement of existing policies, very soon, there will be nothing to study and no where to use valuable training.

(7) Another prerequisite is simplification of environmental regulations and more enlightened application of environmental assessment procedures. To a considerable degree environmental assessment and environmental regulations in DC's are derived from the NEPA model in the U. S. Many DC governments, under pressure from donors and non-government organizations (NGO's), have over zealously applied U. S. style procedures and policies in a context for which they are ill suited. Policies and regulations should be commensurate with the ability of governments to enforce them and commensurate with the ability of local people to comprehend and accommodate them.

(8) Natural resource inventories and demographic information are important ecological prerequisites to development planning and until recently, have been significant constraints. Today, satellite and aircraft imagery provide qualitative and quantitative information about natural resources. Ecosystem models and associated sensitivity analysis enable scientists to predict impacts of development activities when data is limited or obtainable for only a few key parameters. Appropriate technologies are needed to manage and analyze ecological information. Geographic information systems (GIS) are now available and in operation in many DC's (Eros 1991). GIS is a method of data management especially well suited for trend analysis over temporal and spatial gradients. Coupled with remote sensing data, GIS provides rapid assessment of demographic and natural resource trends. With support from the Chinese Academy of Sciences and guidance from The National Remote Sensing Center of the State Science and Technology Commission, over 200 institutes and centers and approximately 3 000 scientists are applying these technologies to conservation and resource management in China (Dozier and Wan 1990).

(9) Too often, scientists fail to realize the importance of political and economic realities as a prerequisite to implementing best science and technology currently available. The best path toward environmentally sound and sustainable development is integration of environmental planning into existing institutions of government. This is far more effective than creating new and independent institutions which may or may not interact with pre-existing ones. Too often environmental planning and protection are "add-ons" to a poorly integrated process of decision making. In China (Fig. 5) pre- existing and decentralized institutions are well integrated into the decision making process. Remember, the structure of planning and management systems should mimic the structure of the

systems being managed.

(10) Lastly, and perhaps most importantly, public participation in decision making is a prerequisite to public receptivity and to truly sustainable development. In the United States the National Environmental Policy Act requires public participation in development decision making. In China (Fig. 4), public opinion is also included in the review and approval of environmental impact assessments. In all countries, as environmental planning becomes an increasingly important component of development planning, NGO's become increasingly numerous and vocal.

In summary, ten ecological prerequisites to achieving environmentally sound and sustainable development have been described. Foremost among these is information transfer in the form of professional environmental training, public environmental education and integration of environmental information into development planning and decision making. The most significant contribution ecological science can make is demonstration of interdependencies within and between ecological systems. Recognition of these interdependencies provides the rational for 2 crucial prerequisites to sustainable development, these being: 1) development and use of conceptual ecosystem models as the organizational framework for development planning and 2) more integrated management of natural resources employing management systems which mimic in structure the systems being managed. The greatest contribution to be made by the emerging discipline of ecological economics is the development of economic models of ecological systems in order that true and total values of ecosystem goods and services might be included in development planning and decision making.

The twin issues of excessive population growth and per capita consumption of resources are conspicuously absent from this list of prerequisites to sustainable development. This is because these issues overshadow all others in the struggle for economic growth, equability and sustainability. Population is not merely one issue among ten. Unless we are successful in curtailing population growth and excessive consumption of resources, success in addressing the other ten issues will do little more than delay inevitable human suffering and environmental decay. Few nations, China being a notable exception, have had the courage to address this most significant constraint to sustainable development.

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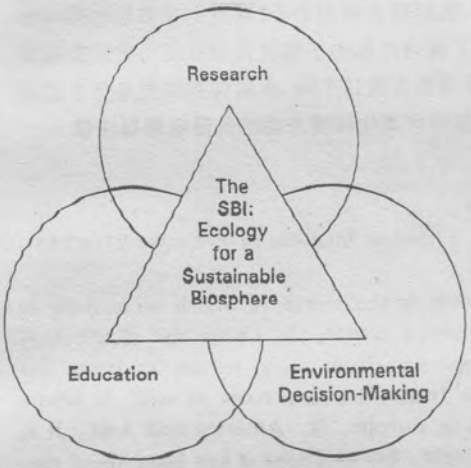

Fig. 1 Interdisciplinary interactions called for by the Sustainable Biosphere Initiative (SBI) of the Ecological Society of America

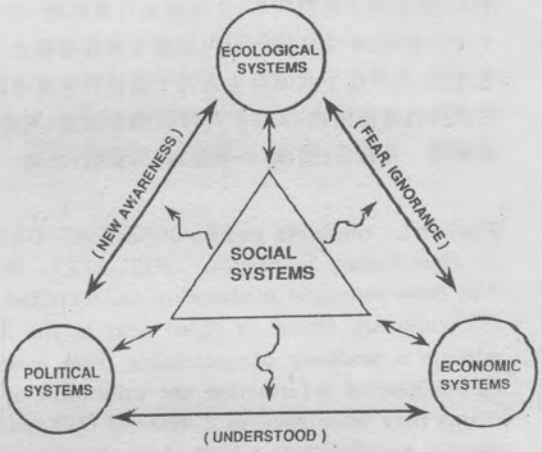

Fig. 2 Interdependencies between political and economic systems

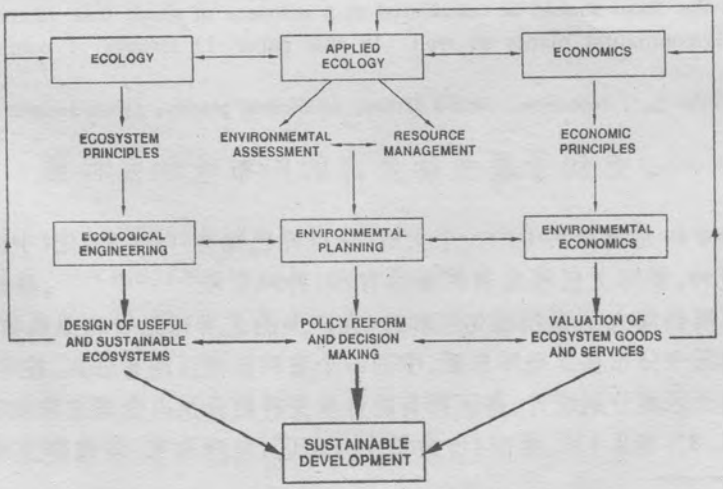

Fig. 3 A simplistic model of interactions between ecologists and economists in the quest for sustainable development