Importance of a Proper Land Concept in Achieving Sustainable Development

Tony Prato

Center for Agricultural, Resource and Environmental Systems
College of Agriculture, Food and Natural Resources
University of Missouri-Columbia
Columbia, MO 65211

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Tony Prato*

A major challenge facing sustainable agricultural and rural development is the protection and preservation of land. Land degradation is a serious global problem which reduces capacity to produce food, fiber and forest products, causes environmental pollution and deteriorates ecological systems. Underlying causes of land degradation are rapid population growth, low income and education, unfavorable climate, production on marginal lands, overexploitation of resources and poor land management. Contemporary economics views land as a reproducible capital asset which can be depreciated without regard to physical consequences and replaced by other forms of capital. This concept of land increases the likelihood of land degradation. Land is not a reproducible asset. It is a primary factor of production having spatially and temporally diverse productivity, vulnerability to degradation and rates of depletion and regeneration. This paper argues that viewing land as a natural asset with diverse physical attributes, appropriately managing the renewable and non-renewable aspects of land and incorporating land degradation in national accounts of economic activity are essential for sustainable development.

Causes and Types of Land Degradation

Land productivity is essentially determined by climate, soils and management. While poor land management can accelerate certain types of land degradation, such as desertification, climate is generally considered an external, uncontrollable determinant of land productivity, In contrast, management is an internal, controllable determinant of land productivity which is influenced by population, culture, income and technology.

Soil degradation is occurring throughout the world. Major types of soil degradation include water and wind erosion, physical degradation (compaction, water logging and subsidence) and chemical deterioration (loss of nutrients, salinization, acidification and pollution). Figure 1 indicates that erosion is the primary type of soil degradation in the world and in Asia. During the 1945-90 period, 1.96 billion hectares of soils (17% of the world's vegetated area) were degraded to some degree. Extreme land degradation has occurred on about 300 million hectares or 3% of world's

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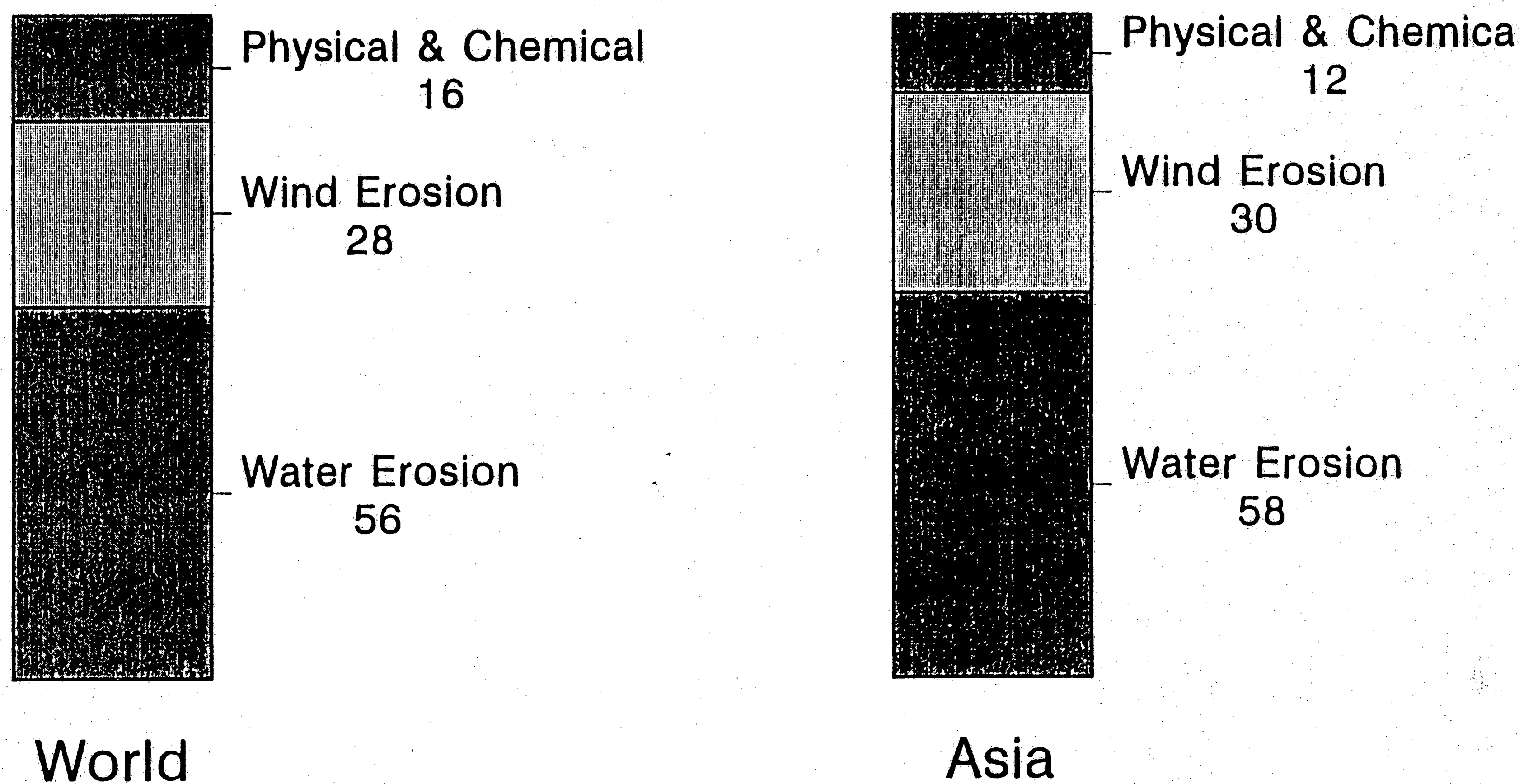
*Professor of Agricultural Economics and Director, Center for Agricultural, Resource and Environmental Systems, College of Agriculture, Food and Natural Resources, University of Missouri-Columbia, Columbia, MO, 65211, USA.

Figure 1. Types of Soil Degradation

Percent



Source: United Nations Food and Agriculture Organization.

vegetated area (World Resources Institute). Large areas of China are affected by severe water erosion. Serious wind erosion occurs in western China and chemical deterioration is prevalent in northern China.

Primary causes of soil degradation are agricultural production, overgrazing, deforestation, overexploitation due to fuelwood collection, and industrialization. Figure 2 indicates that the top three causes of soil degradation in the world and in Asia are overgrazing, agricultural production and deforestation. Deforestation is the number one cause in Asia and overgrazing is the number one cause worldwide.

Land degradation contributes to air and water pollution. Rapid growth in world use of fertilizers since 1970 has increased the nitrate and phosphorus content of runoff and sediments resulting in pollution of rivers and estuaries. Human-induced nutrient discharges into the world's rivers amount to 35 million metric tons of dissolved nitrogen and 0.6 to 3.75 million metric tons of dissolved phosphorus (World Bank). Table 1 shows that use of fertilizers and pesticides has generally increased from 1975-77 to 1982-84. While fertilization rates in the U.S. and China were similar in the 1975-77 period, the U.S. rate decreased slightly and China's rate more than doubled by the 1982-84 period. During the latter period, fertilization rates in China were over two and one-half times greater than in the U.S. Total pesticide use is two to three times greater in the U.S. than in China.

Table 1. Comparison of Fertilization Rates and Pesticide Use for Various Regions

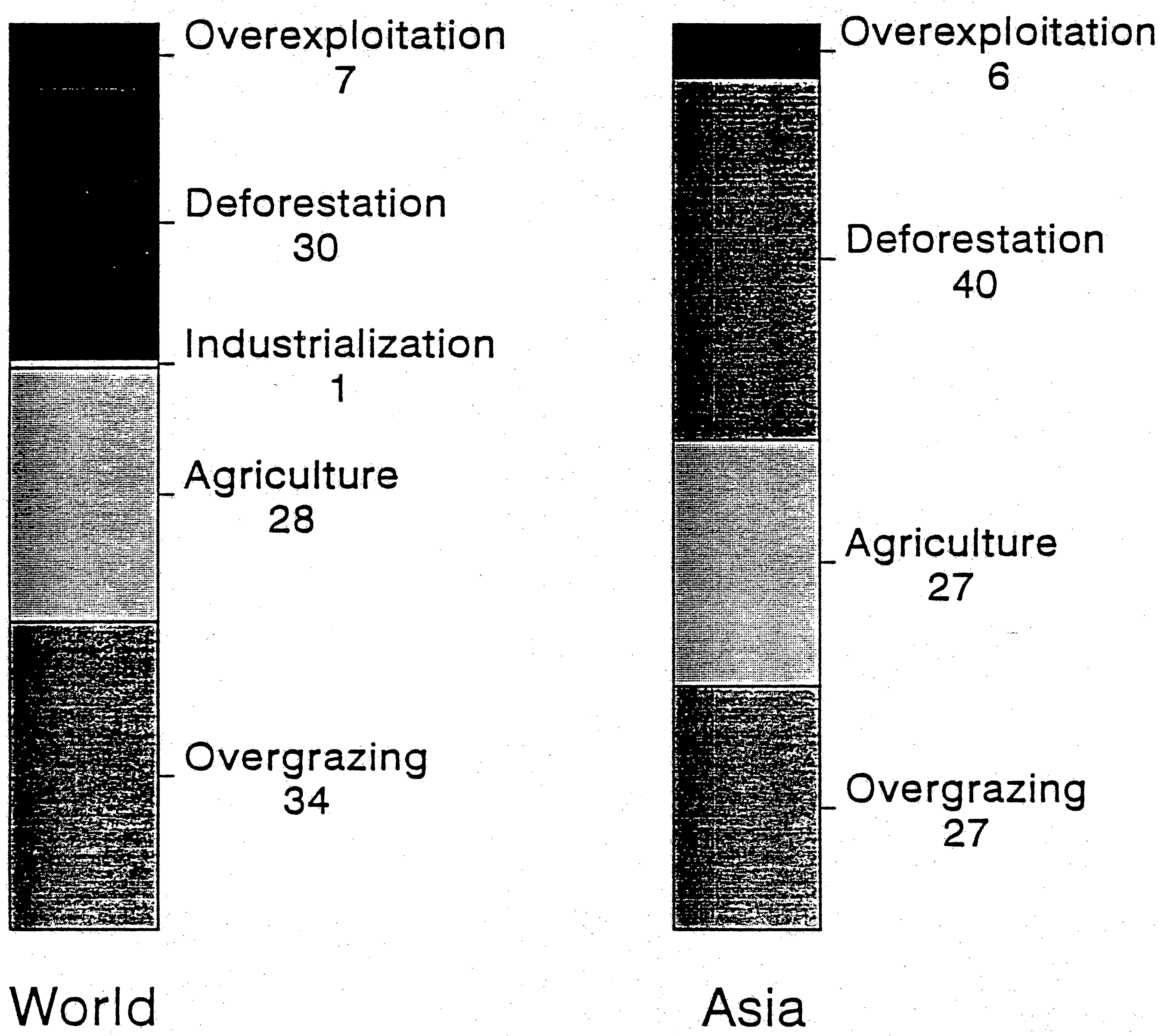
Source/ Period	World	North/Cen America	U.S.	Asia	China
Fertilizer Rates*					
1975-77	73	87	105	56	115
1982-84	97	85	95	111	255
Pesticide Use**					
1975-77	----	---	459,400	---	150,467
1982-84	----	----	373,333	----	159,267

*kg per ha. **metric tons of active ingredients

Source: World Resources Institute. 1992. *World Resources, 1992-93: A Guide to the Global Environment*. New York: Oxford University Press, pp. 274-275.

Figure 2. Causes of Soil Degradation

Percent



Source: United Nations Food and Agriculture Organization

Trends in deforestation for 87 tropical countries indicate that forest resources are being overexploited. From 1981 to 1990, tropical deforestation on a worldwide basis was almost 17 million hectares per year compared to 11.3 million hectares per year in the early 80s. The rate of deforestation increased 50 percent during this period. Regionally, the rate of deforestation is greatest in Asia, followed by Latin America and Africa. Deforestation contributes to land degradation by releasing stored carbon to the atmosphere, reducing biological diversity and accelerating soil erosion.

Land degradation can occur from changes in land use. For example, waterfowl habitat in the U.S. has been significantly decreased by the loss of wetlands. Current wetland areas decreased from 100 million hectares in the 1600s to 40 million hectares today. Eighty-seven percent of the loss in wetlands was caused by drainage of wetlands to allow agricultural activities. Conversion of wetlands to cropland increases soil erosion and the risk of surface and ground water contamination. Likewise the conversion of prairies and forests to cropland accelerates land degradation.

Fertilizer use has increased dramatically due to the relatively low prices of fertilizer, development of hybrid varieties and losses in natural soil fertility. Pesticide use has also risen substantially to reduce potential yield losses from pest damages many of which are caused by the adoption of intensive farming methods (monoculture). Higher rates of fertilization and pesticide use have increased the incidence of surface and ground water contamination throughout the world. Greater rates of deforestation have accelerated the decline in soil, air and water quality. The above trends indicate that land degradation is a serious global problem.

Attaining sustainable development requires that more emphasis be given to reducing land degradation and, in some areas, reclaiming land that has been adversely affected by agricultural, mining and industrial activities. Some have argued that sustainable development is not practical in developing countries faced with rapid growth in population, low income and educational levels, inadequate food supplies and poverty. Yet, delaying sustainable development will likely result in further land degradation which reduces the land's capacity to supply food and fiber products.

Concepts of Land

While land is normally thought of as space, it has a much broader interpretation. As Daly and Cobb point out, land is "nature, creation, the world, the environment, or earth" (Daly and Cobb, p. 97). Land includes soil, water, air, minerals, plants and animals. Concepts of land have been influenced by many diverse and sometimes conflicting ideas. Spiritual, economic and conservation interpretations of land are especially noteworthy.

Spiritual

The most significant reference to land appears in the beginning of the Old Testament. God created the world in six days. In the first five days he created light, sky, land, seas, stars, plants and animals. On the sixth day, God created man in His own image. At every step of creation, God says that His creation is good. Later, man is instructed to have rule or dominion over all the earth and its creatures. Dominion does not imply that man is to subdue the earth.[1] God placed man in the garden of Eden for the purpose of working the land and caring for it.

Native Americans hold strong attitudes toward the land. They believe that man should live as one with the land in a reverential relationship. Ownership of land did not exist among early Native Americans. Their attitude toward the land is reflected in a few lines from Nancy Wood's poem describing the displacement of the Taos Indians from their land:

> For there is no difference between
> The life of a man and the life
> Of all growing things.

Classical economics

For the most part, classical economics viewed land as a primary factor of production that was distinct from labor. In *An Essay on Population,* Robert Malthus (1798 and 1914) argued that population would grow at a geometric rate and human subsistence at an arithmetic rate, causing the human condition to decline over time. In *Principles of Political Economy*, Malthus (1820) solidified the concept of absolute scarcity of land by arguing that geometric growth in population combined with a fixed supply of land would cause the intensity of land cultivation to increase over time resulting in diminishing per capita returns to land and higher food production and labor costs.

David Ricardo agreed with Malthus regarding rapid population growth, rising production costs and declining profits. However, he had a different view about the timing of both diminishing returns to land and rising production costs. Whereas Malthus argued that returns to land would not diminish

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1. A commentary on God's command that man is to rule over all that God created states the following: "As God's representative in the creaturely realm, he [man] is steward of God's creatures. He is not to exploit, waste or despoil them, but to care for them in the service of God and man" (Barker, p. 8).

until the absolute limit on land availability was reached, Ricardo held that average and marginal productivity of land would decrease almost immediately because land of decreasing fertility would be brought into production. Ricardo believed in the relative scarcity of land and subscribed to the labor theory of value espoused by John Locke. Both Ricardo and Karl Marx believed that land did not contribute to a commodity's exchange value.

Adam Smith and John Stuart Mill believed that land contributed value to the production process. Mill noted that land has "active energies by which it co-operates with .. labor" (Mill, p. 23). Mill believed that technological progress would be sufficient to offset diminishing returns to land. However, he expected diminishing returns to non-renewable resources such as coal and metals to increase extraction costs for these resources, regardless of population growth. Mill also appears to be the earliest economist to address the amenity values provided by land such as solitude, natural beauty and the provision of habitat for flora and fauna. Mill's philosophy regarding amenity values of the land is similar to the philosophies of conservationists such as Henry David Thoreau and John Muir.

William Stanley Jevons' argued that dependence on exhaustible energy resources, notably coal, posed a serious threat to economic growth in industrialized countries such as Britain. He believed that unlimited growth in coal consumption would exhaust coal reserves, resulting in significantly higher costs of production and coal prices. Higher coal prices combined with the loss of coal export markets were expected to devastate the British economy. Ways out of this dilemma systematically rejected by Jevons' included substitution of petroleum for coal, technology-based decreases in coal mining and transportation costs, and importation of coal from other countries.

Neo-classical economics

Neo-classical economics is based on an anthropocentric (human-centered) view that the goal of economic activity is to maximize human satisfaction. Apart from externalities and government interference, market prices are expected to reflect the scarcity value of all commodities. The cornerstone of neo-classical microeconomics was laid by Alfred Marshall. Marshall agreed with classical economists that land was subject to diminishing marginal returns. He believed increasing scarcity of land would lead to higher land prices which would stimulate farmers to seek new knowledge and better management techniques resulting in higher agricultural productivity. Technological progress and the substitution of capital for land ensured that land scarcity would not constrain economic growth. In the neo-classical model, land is treated as a reproducible capital asset which, like any other form of capital, was to be exploited for the benefit of mankind. Alexander Hamilton, Henry C. Carey and Wilhelm von Hermann also viewed land as reproducible capital.

Marshall did recognize that the environment provided not only resources for production, but also "free gifts of nature" such as natural beauty, scenery, fresh air, light and fresh water. Marshall observed that the "services which land renders to man, in giving him space and light and air in which to live and work" are typically under valued or not valued at all in the market place (Marshall, pp. 138-139). Despite these references to land, Marshall viewed land as an ordinary production input.

While neither a classical nor neo-classical economist, Karl Marx's philosophy leads to the conclusion that "things supplied by nature 'gratis' and the services of capital proper have no value" (Georgescu-Roegen, pp. 288-289). In a Marxian world, value is created only when a natural resource is combined with labor.

In their 1922 book, *Outlines of Land Economics*, Richard Ely et al. astutely observed that land received less attention in economics than labor and capital. They claimed that economists should view land as "the forces of nature so far as they have economic significance" (Ely et al., p. 3). In their 1940 book *Land Economics,* Ely and George S. Wehrwein recognized that land must be managed based not only on the desires of man, but also on the "operation of nature's laws" (Ely and Wehrwein, p. 25). This philosophy acknowledges the physical aspects of land which were generally ignored by neo-classical economists.

Conservationism

Conservationists have been the most vocal and influential proponents of protecting America's natural resources. The spirit of the early conservation movement is captured in the lifestyles and achievements of a few noteworthy conservationists.

George P. Marsh (1801-1882) was a scientist and Vermont congressman who laid much of the foundation for modern conservationism. In his seminal book *Man and Nature*, Marsh expressed the diverse and complex interactions between man and nature in terms of a "nature-man continuum." Along the continuum, man affects nature and nature affects man. There are feedback loops. Marsh contended that man's complex dependence on nature extended far beyond the classical economic concept of diminishing marginal returns to agricultural land and mineral development. Availability of land did not have to limit economic activity. Nature could support man indefinitely provided the ecological impacts of man's activities were not excessive. A balance needed to be achieved between man and the environment. Marsh's viewpoints are an early manifestation of the ecological concept of resource and environmental capacity which is often ignored and even rejected by some contemporary economists. Marsh's interest in achieving harmony between man and the environment is echoed in the writings of Wendell Barry and Wes Jackson.

John Muir (1838-1914) was motivated and strengthened through his close relationship with nature. Muir's first love was the study and preservation of the wilderness. His writings exhort the "glories of nature" which he experienced during his many modest (stale bread and tea) but ambitious treks through the Sierra-Nevada mountains, Alaska and other areas of the U.S. During his many wilderness odysseys, Muir collected field data for his scientific investigations. Muir was instrumental in the 17-year struggle to establish a national park in Yosemite Valley and a national park system in the U.S. Both efforts were successful. He was given major credit for preserving the Grand Canyon. John Muir was the founder and first president of the Sierra Club, an activist grass roots organization established in 1892. His biggest defeat was the unsuccessful campaign to save Hetch Hetchy Valley in Yosemite Park from being flooded to form a water supply reservoir for San Francisco.

Aldo Leopold (1886-1948) followed in the same tradition as John Muir. He is best known for his land ethic which views land as a community of soils, water, plants and animals that are worth preserving. Leopold stressed the "ecological necessity" of man's responsibility to the land. The ethic did not require that land resources remain idle. Use could occur as long as provision was made for the continued existence of land, "and, at least in spots, continued existence in a natural state" (Muir, p. 240).

Leopold considered it inappropriate to base land conservation decisions solely on economic criteria. Many services provided by the land were deemed essential for its proper functioning, even though they had no commercial value. He wanted land managers to have an "ecological conscience" that would motivate them to take personal responsibility for maintaining the health of the land. Leopold reasoned that land managers needed to put aside the narrow mindset that "economics determines all land-use" and embrace what is ethically and aesthetically right for the land. This required preserving the land's integrity, stability and beauty.

Space does not permit consideration of the many contemporary works that deal with the relationship between economic growth and land or natural resource availability. Many of these studies grew out of the concern over natural limits to growth which surfaced 20 years ago. Suffice it to say that several studies have reached the conclusion that there are natural limits to economic growth. Actions proposed to deal with this problem include reducing population growth, limiting the rate of use of renewable and non-renewable resources, keeping the throughput of material and energy below ecological limits, reducing inequities in the distribution of income and wealth, ensuring that resource and commodity prices reflect the full social cost of extraction and use, taxing non-renewable resources, regulating environmental pollution and others.

Criticism of Neo-classical Land Concept

Neo-classical economists embraced the dualism expressed by philosophers such as Descartes and Kant that man and nature are separate entities with man having primacy. They viewed land as a reproducible capital asset which can be replaced, in part, by labor and other forms of capital and whose productivity could be increased by technological progress. George Gilder illustrates this viewpoint by his comment that "The United States must overcome the materialistic fallacy: the illusion that resources and capital are essentially things, which can run out, rather than products of the human will and imagination which in freedom are inexhaustible" (Gilder, p. 232). Daly and Cobb believe this conclusion is misplaced because it is not consistent with physical realities such environmental pollution. They observe: "There seems to be no way to take the evidence of science and of universal experience seriously without affirming the reality of the natural world and the place of the human being as a part of it" (Daly and Cobb, p. 109).

The neo-classical concept of land is invalid and misleading for several reasons First, it disregards the unique physical attributes of land and the need to preserve the land's capacity to supply raw materials and energy for economic production. It also ignores the land's capacity to assimilate wastes and to provide amenity services. Other things equal, a neo-classical concept of land increases the likelihood of land degradation. Treating land like reproducible capital, such as a tractor, implies that after a parcel of land wears out, it can be replaced with other land parcels or another form of capital.

Unfortunately, land is not like a tractor. The only time path for non-renewable resources is depletion. When all the oil in the U.S. is depleted, which is expected to occur by the year 2020, the only choices are to rely on oil imports or to use other energy sources. Even renewable resources can be overexploited by using them at rates that exceed the natural rate of regeneration. In some extreme cases, overexploitation can have dire social consequences. Lowdermilk concluded that civilizations in the Fertile Crescent apparently collapsed because land degradation proceeded to the point where food and fiber production was no longer possible. Land degradation in this region resulted from extensive erosion, sedimentation of the Tigris and Euphrates Rivers and tributaries, siltation of irrigation canals and salinization of poorly drained soils (Parr and Hornick).[2] Not only can renewable resources be degraded by overexploitation, but also the environment's capacity to assimilate wastes can be exceeded. When this occurs, there is environmental pollution and associated damages to human life and ecological systems.

Second, the idea that technological progress increases land productivity and reduces dependence on land is misleading. Most of the growth in agricultural productivity has been achieved by increasing the use of raw materials and capital relative to land, and improving management. Since crop yields per acre of land and per hour of labor have increased dramatically over the past 50 years, it appears that land has become more productive. However, most of the raw materials and capital used to increase the productivity of agricultural land are in the form of irrigation water and associated facilities, fertilizers, pesticides and farm machinery and equipment. Production of these inputs requires substantial amounts of raw material and energy.

From 1950 to 1985, worldwide use of energy in agriculture increased from 276 to 1,903 million barrels of oil equivalent, a sevenfold increase, and world use of fertilizers in agriculture increased ninefold (Brown). Use of farm tractors quadrupled and area under irrigation tripled (Sloggett). Intensity of energy use in agriculture also increased. From 1950 to 1985, energy use per ton of grain produced increased from 0.44 to 1.14 barrels of oil equivalent, a two and one-half fold increase (Brown and Postel). Therefore, increases in land productivity from the substitution of raw materials and capital for land have come at the expense of depleting non-renewable energy resources.

Third, the notion that production can be increased by increasing capital or labor while holding land (resources) fixed has been questioned from a thermodynamic viewpoint. As Daly and Cobb point out, ".. if the flow of resource inputs is held constant, then there is nothing from which more output could be made, not even by working harder, more efficiently, or for longer hours. The law of conservation of matter-energy forbids increasing material output when material input (resources) is held constant" (Daly and Cobb, p. 112). As we have seen from the second criticism, land in its broadest sense is not really being held constant when more fertilizers, pesticides and tractors are applied to a fixed acreage. Increasing the use of

2. Parr and Hornick define the Fertile Crescent as "a curving strip of land extending north through parts of Iran and Iraq, westward across northern Syria and southeastern Turkey, and southward through Lebanon and Israel and into the Nile Valley."

these inputs is not possible without consuming minerals and energy which are part of the land.

Fourth, some of the production technologies/practices that accompany greater use of raw materials and capital in agriculture have contributed to land degradation. As mentioned earlier, about 28% of global soil degradation is the result of agricultural production. Prime examples of technologies that have accelerated soil degradation are the moldboard plow and cultivation up and down slopes. Fortunately, both practices are becoming less prevalent, at least in the U.S. In addition, expanded use of fertilizers and pesticides has increased surface and ground water contamination in agricultural and rural areas.

The fifth criticism deals with the tendency of many technologies to increase the amount of land devoted to food and fiber production. In many parts of the world, water, fertilizers, pesticides and agricultural machinery/equipment have been used on an expanded acreage base. Prime examples of this in the U.S. are the development of irrigated agriculture in the western U.S., removal of wind breaks and vegetated fence rows in the Midwest and the conversion of prairie and wetland to cropland in the Great Plains and Midwest. Unfortunately, environmental impacts seem to increase when the technology embodied in agricultural inputs is applied to a larger land base.

Towards a Proper Land Concept

If the neo-classical concept of land is invalid and misleading, then what is a proper land concept and how can it be implemented? A proper concept of land is provided by the biblical view of man's stewardship of the land, the classical economic perspective of land as a unique, primary factor of production and the conservationist's position regarding the ecological necessity of proper land management. Developing and applying a concept of land based on these principles would be compatible with and supportive of sustainable development.

A proper concept of land respects all three major functions of land, namely: primary factor of production having unique physical properties, a collection of diverse ecosystems having limited and varying capacities to assimilate wastes generated by economic activities, and a provider of amenity services such as solitude and beauty. Under this concept, land is not treated as a reproducible capital asset. Rather it is managed according to whether the resource in question is renewable or non-renewable. Non-renewable resources would be managed based on the principle recommended by El Serafy. Specifically, net returns from sale of a non-renewable resource such as petroleum or coal would be divided into income and capital accounts. Funds accumulated in the capital account would be invested in a renewable resource, such as solar energy, that would be capable of yielding an income equivalent to that provided by the non-renewable resource at the time it is exhausted. Renewable resources such as soil, forests, fish and hydropower would be utilized at a rate that does not exceed regeneration.

Discharge of waste products to the environment would not be allowed to exceed the assimilative capacities of different ecosystems or environmental media (air, water and soil). This would ensure that ecosystems/media are not degraded by wastes. Environmental capacities are likely to place upper limits on the use of certain technologies, products and practices. For example, further depletion of the ozone layer would be halted by eliminating the use of CFCs. The threat of global warming would be lowered by reducing carbon dioxide emissions. Part of the natural resource base would be set aside to provide unique services such as solitude and beauty and to preserve ecological diversity (wilderness and biological reserves).

A proper concept of land also requires adopting an accounting system to keep track of resource depletion and environmental pollution. Accounting can be done by either adjusting gross domestic product or similar measures of economic activity for resource depletion and environmental pollution or setting up separate physical accounts. The current United Nations System of National Accounts is decidedly biased against adjusting gross domestic product. While this system allows depreciation of man-made capital, no adjustment is made for depreciation of natural capital (land). Some countries, notably Norway, France and Canada, have developed resource accounts which track physical changes in the resource base and environmental quality.

The biases that result from not accounting for resource depletion or environmental pollution can be significant. For example, Repetto et al. compared actual Gross Domestic Product (GDP) to Net Domestic Product (NDP) for Indonesia. NDP equals GDP minus estimated depreciation for petroleum, timber and soils. During the 1971-84 period, GDP increased at an annual average rate of 7.1% compared to only 4% for NDP. Repetto et al. concluded that "conventionally measured gross domestic product substantially overstates net income and growth after accounting for consumption of natural resource capital (Repetto et al., p. 4). Daly and Cobb developed an Index of Sustainable Economic Welfare (ISEW) for the U.S. by adjusting Gross National Product (GNP) for depletion of fuels, minerals, wetland and farmland, environmental damages from air, water and noise pollution, climate change and other factors. Table 2 compares annual average growth in GNP and ISEW on a per capita basis for several time periods.

Table 2. Comparison of Average Annual Percentage Growth in Per Capita GNP and Per Capita ISEW in the U.S.

Time Period	GNP	ISEW
1950-86	1.90	0.53
1960-70	2.64	2.01
1970-80	2.04	-0.14
1980-86	1.84	-1.26

The table shows that growth in GNP is substantially higher than growth in ISEW. Since 1970, growth in the ISEW has been negative, whereas growth in GNP has been positive.

In addition to proper accounting of resource depletion and environmental degradation, economic evaluation procedures could be modified to afford better protection of the land. Alternative soil and water conservation strategies are typically evaluated in terms of the net present value of the strategy. If net present value of the strategy is positive (negative), it is considered economically feasible (infeasible). Present value calculations require discounting future streams of benefits and costs to place all dollars on a comparable basis. Discounting reduces the present value of practices which slowly reduce land degradation or whose benefits occur well into the future.

Howarth and Norgaard argue that if the objective is to protect natural resources for the benefit of future generations, it would be better to assign property rights in natural resources to future generations. If property rights to un-degraded land are assigned to future generations, these rights would be protected regardless of cost. Future benefits of current efforts to protect land would not be discounted under this scheme because they are a property right. This scheme would require determining the allocation of property rights in land and environmental protection to future generations. However, protection of these rights would become a social decision, not an economic one.

Conclusions

Protection of land is a major challenge of sustainable agricultural and rural development. Since poor land management contributes to land degradation, a proper concept of land should facilitate land protection. Classical economics viewed land as a unique, primary factor of production. Neo-classical economics drifted away from the classical view of land. It embraces the view that land is a reproducible capital asset which can be replaced, in part, by labor and other forms of capital and whose productivity can be enhanced by technological innovation. Several studies have concluded that land, in its broadest sense, is a constraint on economic activity.

The neoclassical economic concept of land is inconsistent with sustainable development. A more appropriate concept of land is one based on the biblical view of man's stewardship of the land, the classical economic perspective of land as a unique, primary factor of production and the conservationist's position that a land ethic is an ecological necessity. This concept of land requires implementation of national accounts that track resource depletion and environmental pollution. Managing land according to these principles is compatible with and supportive of sustainable agricultural and rural development.

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