Resources, Sustainability, and Food Security

by
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The notion of food security has expanded in recent years from a relatively static focus on food availability to one that recognizes longer term concerns about access and resources. At the same time, economists have been working to incorporate changes in the quality and quantity of natural and other resources into measures of national income and wealth. A review of recent data suggests the potential for improved analysis of sustainable resource use and food security.

Resources and Food Security

Food security is generally defined in terms of "access by all people at all times to sufficient food for an active and healthy life" (World Bank, 1986; World Food Summit, 1996). This represents a significant advance over earlier definitions that focused on global food availability, yet careful consideration of food security requires moving beyond even access to food and recognizing the choices that households and regions face when incomes fall short (Dasgupta, 1993). Of special interest are the tradeoffs that low incomes force between meeting current consumption needs and protecting the resources needed to meet consumption and other needs over the longer term.

Resources can be classified in a variety of ways. Natural resources (e.g. land and water), produced resources (e.g. roads and factories), and human resources (e.g. skilled and unskilled labor) are generally recognized, if not always easy to measure. Social resources are comprised of the institutions and cultural patterns on which functioning societies are based (Serageldin, 1996).

Resources are critical to food security because they determine the ways in which individuals, households, and countries gain access to food through production and exchange. These relationships are illustrated in the right-hand side of figure C-1. Resources are also related to food security in a second significant way. Once individuals or groups have engaged in production and exchange, they can allocate the resulting income, along with their remaining stock of resources, to consumption and investment. Consumption and investment in turn affect the quality and quantity of the human and other resources that are available in subsequent periods. These concepts are illustrated in the left-hand side of figure C-1.

Recognizing the tradeoff between consumption and investment in other resources is particularly important in poor countries and households, where small increases or decreases in the level of consumption can have large effects on health and nutritional status. Proximity to a minimum consumption threshold, representing the "sufficiency" component of food security, highlights the tradeoff between alternative forms of investment that poor households may face. Specifically, households with insufficient income may be forced to choose which forms of investment will be curtailed, and thus which types of resources will be degraded or depleted over time. For example, resource-poor households may be forced to cultivate their land intensively, thereby degrading it over time, in order to generate enough income to avoid undernourishment in the short run (Perrings, 1989; Mink, 1993). Alternatively, they may accept a certain degree of undernourishment rather than deplete their natural or produced resources. In fact, while simplistic notions of food security imply that the former strategy would be preferred, evidence (e.g. Sen, 1981; de Waal, 1989) suggests that many resource-poor households choose the latter.

This is why it is necessary to incorporate resources into a full understanding of food security. Consumption that is maintained at sufficient levels only by irreversible degradation or depletion of natural, produced, and/or social resources will not be sustainable "at all times," and can hardly be described as part of a food-secure livelihood strategy in the long run. Likewise, protection of natural and other resources that is achieved only at the expense of necessary consumption levels, and thus minimum standards of human health, will not be sustainable in the long run either.

Trends in Food Availability and Access

As discussed in the Overview of this report, the gap between the amount of food available (i.e. production plus commercial imports) and the amount of food needed to maintain either status-quo or nutritionally adequate consumption levels is projected to increase in most of the 67 countries studied in this report over the next 10 years. The total "food gap to maintain consumption" is projected to grow from 8 million tons in 1997 to 18 million tons in 2007, most of it in

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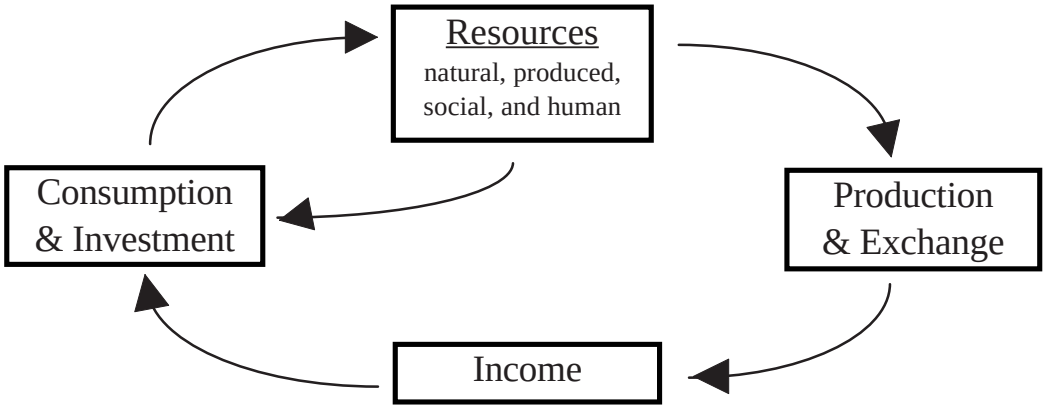
Figure C-1--The Role of Resources in Food Security



Source: Maxwell and Wiebe (forthcoming).

Sub-Saharan Africa and Asia. The total "nutritional food gap" is projected to grow from 15 million tons in 1997 to 24 million tons in 2007, also primarily in Sub-Saharan Africa and Asia.

Among the factors contributing to these growing food gaps are low yields for food crops (table C-1), which limit production's role in meeting food needs. Sub-Saharan African yields for cereals (1 ton per hectare), roots and tubers (8 tons per hectare), and pulses (0.5 tons per hectare) are well below world (and even developing-country) averages. While yields are higher in South Asia, access to food is limited by lower per-capita incomes (at $350 per year), and a larger share of the population (43 percent) lives in poverty. Low incomes limit poor countries' ability to compensate for production shortfalls through commercial imports. The consequences of the resulting food gaps are evident in indicators of consumption in developing countries. About 43 percent of Sub-Saharan Africa's people are chronically undernourished, compared with 22 percent in South Asia and 12-16 percent in other developing areas. The greatest numbers of chronically undernourished people live in Asia (Pinstrup-Andersen and Pandya-Lorch, 1997).

Food production, access, and consumption are important components of current food security, but it is also essential to consider the longer term interactions between food security and sustainable resource use. Recognizing the urgency of immediate consumption concerns, for example, it is not surprising that gross savings rates in Sub-Saharan Africa are less than half those in the East Asia and Pacific region. Low savings rates may reflect the short-term priority of consumption over investment in other resources, but maintenance of natural and other resources remains critical to food security over the long term. It is important to note that the gross savings rates reported in table C-1 fail to reflect changes in the stocks of many natural, human, and other resources that are associated with sustainability and food security, ranging from deforestation and carbon dioxide emissions to institutional decline and malnutrition-related disease.

Economists have begun trying to better incorporate such changes into measures of national income. For example,

Table C-1--Selected Indicators of Food Availability and Access

Indicator	Low- and Middle-Income Economies							HIE	World
	SSA	EAP	SA	ECA	MENA	LAC	All		
Production									
Cereals yields *(tons/hectare, 1996)*	1.0	3.2	2.2	1.7	na	2.5	2.6	3.3	2.9
Roots & tubers yields *(tons/hectare, 1996)*	8.0	11.0	15.3	12.7	na	11.6	11.6	17.6	13.0
Pulses yields *(tons/hectare, 1996)*	0.5	0.9	0.6	1.4	na	0.7	0.7	1.6	0.8
Income									
GNP per capita *($/capita, 1995)*	490	800	350	2,220	1,780	3,320	1,090	24,930	4,880
Poverty *(% living on < $1/day, 1993)*	39	26	43	na	4	24	29	na	na
Consumption & investment									
Undernourishment *(% chronically undernourished, 1992)*	43	16	22	na	12	15	21	na	na
Gross savings *(% of GDP, 1995)*	16	38	20	na	na	19	22	21	21
Genuine savings *(% of GNP, 1993)*	-1	21	6	na	-2	6	9	14	na

Notes: SSA = Sub-Saharan Africa; EAP = East Asia and Pacific; SA = South Asia; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and Caribbean; HIE = High-Income Economies; na = not available.

Sources: FAO (1997), Pinstrup-Andersen and Pandya-Lorch (1997), World Bank (1997a and 1997b).

adjusting estimates of savings to reflect changes in the value of natural and human resources yields the "genuine savings" data presented in table C-1. Genuine savings rates in Sub-Saharan Africa and the Middle East and North Africa are negative (as they have been for the past several decades), while rates in East Asia and the Pacific are high and rising (World Bank, 1997b). These trends suggest the need to look beyond short-term indicators of food availability and access to explore the longer term links between food security and resource use.

Resource Trends in Developing Economies

In general, resource priorities change as economies evolve. In low-income economies, priority is typically given to issues related to the management of natural resources for poverty alleviation and food security (UNEP, 1997). As economies grow, priority may shift to include resource problems associated with industrialization and urbanization, such as air and water quality and the treatment and disposal of waste. While analysis of local and national resource-use and food-security decisions requires disaggregated data, broader patterns are revealed in regional data reported by the World Bank and other sources. This section presents a brief overview of selected data from these sources to illustrate some of the resources and processes depicted in figure C-1.

Natural resources. Selected indicators of natural resources are presented in table C-2. About 11 percent of global land area is currently used as cropland, ranging from 6 percent in the Middle East and North Africa to 45 percent in South Asia. Cropland per capita ranges from 0.1 hectare in East Asia and the Pacific to 0.6 hectares in the low- and middle-income economies of Europe and Central Asia. In recent decades, cropland area has increased at 0.3 percent annually worldwide, and as high as 1.3 percent annually in Latin America and the Caribbean. This increase often represents expansion of cultivation onto marginal lands, such as those with shallow soils or steep slopes. Permanent pasture has remained relatively constant in area, indicating that the majority of the net increase in cropland area has come at the expense of areas formerly under forest or woodland cover. Deforestation has occurred most rapidly, in percentage terms, in East Asia and the Pacific and in Latin America and the Caribbean. Nationally protected areas have increased relatively rapidly in recent decades, although it is difficult to assess the true effectiveness of such protection. In any case, Rosegrant, Ringler, and Gerpacio (1997) argue that land conversion will slow in the next two decades, and will not threaten global food supplies in the foreseeable future.

Even if the rate of land conversion for agriculture slows in the coming decades, land already used for agricultural production is also subject to increasingly intensive production, which can lead to degradation via nutrient depletion and soil erosion. For example, Bumb and Baanante (1996) report that in many countries of Sub-Saharan Africa, soil nutrients are removed at rates 3 to 4 times those of nutrient replenishment, while Lal (1995) estimates that soil erosion has reduced crop yields in Sub-Saharan Africa, relative to what they would have been otherwise, by about 6 percent. Crosson (1997) counters that erosion-induced on-site productivity losses are actually quite low, less than 0.5 percent per year, although concern may still be justified where soil erosion has significant off-site effects, as well as in particular areas where soil losses are higher. Scherr and Yadav (1996) identify a number of such "hot spots" where land

Table C-2--Selected Indicators of Natural and Produced Resources

Indicator	Low- and Middle-Income Economies							HIE	World
	SSA	EAP	SA	ECA	MENA	LAC	All		
Natural resources									
Cropland *(hectares/capita, 1994/95)*	0.3	0.1	0.2	0.6	0.2	0.3	0.2	0.4	0.3
Water use *(% of annual renewable water, various years)*	1	8	12	19	73	2	6	11	7
for agriculture *(% of annual renewable water, various years)*	1	7	11	9	65	1	5	4	5
Cropland *(% of total land area, 1994)*	7	12	45	13	6	7	11	12	11
Permanent pasture *(% of total land area, 1994)*	34	34	10	16	24	29	27	24	26
Forest *(% of total land area, 1990)*	24	26	14	35	4	49	29	35	30
Nationally protected areas *(% of total land area, 1994)*	6	6	4	4	3	7	5	12	7
Cropland *(annual % change in area, 1965-89)*	0.7	0.3	0.2	0.1	0.1	1.3	0.5	0.2	0.3
Permanent pasture *(annual % change in area, 1965-89)*	0.0	-0.2	-0.4	0.0	0.0	0.5	0.1	-0.1	0.0
Forest *(annual % change in area, 1965-89)*	-0.4	-0.7	0.3	0.2	0.2	-0.5	-0.4	-0.1	-0.2
Nationally protected areas *(annual % change in area, 1972-90)*	1.9	14.0	10.7	7.3	6.9	8.0	5.6	7.1	6.3
Produced resources									
Irrigation *(% of cropland, 1989)*	1	10	28	5	6	2	6	3	5
Fertilizer consumption *(kg/arable hectare, 1992/93)*	15	206	74	57	64	52	79	112	87
Mechanization *(tractors/1,000 arable hectares, 1994)*	1		14*	18	na	12	8	31	19
Energy use *(tons of oil equivalent/capita, 1994)*	0.2	0.6	0.2	2.6	1.2	1.0	0.8	5.1	1.4
Fuelwood and charcoal *(% of total energy used, 1989)*	66	10	25	1	1	13	13	1	5

* Average for Asia as a whole.

Notes: SSA = Sub-Saharan Africa; EAP = East Asia and Pacific; SA = South Asia; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and Caribbean; HIE = High-Income Economies; na = not available.

Sources: FAO (1997), World Bank (1992, 1995, and 1997a).

degradation poses a significant threat due to soil erosion, nutrient depletion, deforestation, salinization, and other processes. They report that degradation of agricultural land and permanent pasture is most extensive in Africa (65 percent and 31 percent, respectively), while degradation of forest and woodland is most extensive in Asia (27 percent).

Water is abundant globally but scarce in many regions (UNEP, 1997). Only 7 percent of annually renewable freshwater is used worldwide each year. As Rosegrant (1997) explains, however, increased use is difficult because most of the remainder is lost to evaporation or flooding, or is distributed unequally relative to population or across seasons. In contrast to land resources, Rosegrant, Ringler, and Gerpacio (1997) argue that rapid growth in water demand, in combination with the high cost of developing new water sources, could threaten future growth in food production. Agriculture currently accounts for the majority of water used in most low- and middle-income regions.

One final component of natural resources is the earth's atmosphere, a global resource that is being modified by human activities on an unprecedented scale. Most notable are emissions of carbon dioxide from the combustion of fossil fuels, which are associated with global warming and its possible effects on the location, productivity, and variability of agricultural production. Given the potential for farmers to adapt over time, global warming is not expected to constitute a threat to food production on a global scale, although some resource-poor regions, particularly those in tropical latitudes, may suffer reductions in food availability and access (Darwin et al., 1995; Schimmelpfennig et al., 1996).

Produced resources. Selected indicators of produced resources are also presented in table C-2. South Asia has the highest proportion of cropland irrigated (28 percent), while the East Asia and Pacific region applies fertilizer most intensively (206 kilograms per hectare). Sub-Saharan Africa lags in irrigation (one percent of cropland), fertilizer use (15 kilograms per arable hectare), and agricultural mechanization (one tractor per 1,000 hectares of arable land). Per-capita energy use varies by a factor of 10 from Sub-Saharan Africa and South Asia to the Europe and Central Asia region, which uses energy at about half the level of the high-income economies. Even more dramatic are differences in the share of energy derived from fuelwood and charcoal, ranging from 1 percent in the low- and middle-income economies of Europe and Central Asia and the Middle East and North Africa to 25 percent in South Asia and 66 percent in Sub-Saharan Africa. Different patterns of energy use contribute to different forms of resource degradation. Fuelwood and charcoal burning contribute to deforestation, for example, while fossil fuel combustion releases carbon dioxide and other gases and solids that may affect climate.

Social resources. Indicators of social resources are important for food security in two basic ways. First, they indicate the potential for future economic growth and income generation, and thus the ability to command sufficient access to food. And second, they indicate the ability of society to compensate its members when they experience shortfalls in production, availability, or access to food. Table C-3 presents indicators of factors that affect political and economic activity, as well as indicators associated with public goods and services such as health and education. Health expenditures (both public and private) are lowest in the East Asia

Table C-3--Selected Indicators of Social and Human Resources

Indicator	Low- and Middle-Income Economies							HIE	World
	SSA	EAP	SA	ECA	MENA	LAC	All		
Social resources									
Health expenditures *($/capita, 1990)*	24	11	21	142	77	105	41	1,860	329
Water supply *(% of population with access, 1990)*	47	72	74	90	70	76	na	96	73
Sanitation *(% of population with access, 1990)*	35	85	15	85	59	69	na	86	60
Female primary education* *(% of age group enrolled, 1993)*	65	116	87	97	91	na	99	103	99
Male primary education* *(% of age group enrolled, 1993)*	78	120	110	97	103	na	110	103	109
Democracy index *(rank, 1994; least democratic = 1)*	2	na	3	4	1	5	na	6	na
Obstacles to economic activity *(rank, 1997; worst = 1)*									
Property rights/corruption	1	na	3	3	2	1	na	5	na
Taxes	2	na	2	1	3	5	na	1	na
Human resources									
Population *(millions, mid-1995)*	583	1,706	1,243	488	272	478	4,771	902	5,673
Population growth *(annual % change, 1990-95)*	2.6	1.3	1.9	0.3	2.7	1.7	1.6	0.7	1.5
Urban population growth *(annual % change, 1980-95)*	5.0	4.2	3.4	1.6	4.2	2.8	3.3	0.7	2.5
Labor force in agriculture *(% of total labor force, 1990)*	68	70	64	23	36	25	58	5	49
Adult literacy *(%, 1995)*	57	83	49	na	61	87	70	na	na
Life expectancy *(years, 1995)*	52	68	61	68	66	69	65	77	67
Disease burden *(disability-adjusted life years lost due to malnutrition-related causes, per 1,000 population, 1990)*	87	9	52	2	29	19	na	1	28

* Enrollment may exceed 100% because of the inclusion of students younger or older than the standard primary-school age group.

Notes: SSA = Sub-Saharan Africa; EAP = East Asia and Pacific; SA = South Asia; ECA = Europe and Central Asia; MENA = Middle East and North Africa; LAC = Latin America and Caribbean; HIE = High-Income Economies; na = not available.

Sources: World Bank (1993 and 1997a).

and Pacific region, at $11 per capita. Access to clean water is lowest in Sub-Saharan Africa, while South Asia suffers the lowest access to sanitation services. Male enrollment in primary education is near complete everywhere except in Sub-Saharan Africa, but female enrollment lags in most regions.

Table C-3 also includes data on the State's performance in relation to political and economic participation. The democracy index is an ordinal ranking based on a variety of indicators described in the World Bank's 1997 *World Development Report* (1997a, p. 112), and ranges from a low in the Middle East and North Africa to a high (relative to other low- and middle-income economies) in Latin America and the Caribbean. The *Report* also presents results from a survey of business people on obstacles to economic activity. Property rights and corruption were identified as the principal obstacles in Sub-Saharan Africa and in Latin America and the Caribbean, while taxes were identified as the principal obstacle in Europe and Central Asia. (Infrastructure was identified as the principal constraint in South Asia and the Middle East and North Africa.)

Human resources. Selected indicators of human resources are also presented in table C-3. World population was 5.7 billion in mid-1995, about half of it located in Asia. Annual population growth rates vary widely across low- and middle-income economies, ranging from 0.3 percent in Europe and Central Asia to 2.6 percent in Sub-Saharan Africa and 2.7 percent in the Middle East and North Africa. Global population growth has slowed more than previously expected, to 1.5 percent per year, due to faster than expected fertility declines in South Asia and Sub-Saharan Africa (United Nations, 1996). Urban populations are growing particularly rapidly, especially in Sub-Saharan Africa, East Asia and the Pacific, and the Middle East and North Africa. Nevertheless the bulk of the labor force in the most heavily populated regions (i.e. Asia and Sub-Saharan Africa) remains in agriculture, suggesting the importance of improved agricultural performance to simultaneously increase rural incomes and urban food supplies.

In addition to indicators of quantity, table C-3 also presents crude indicators of the quality of human resources. Poverty and the burden of malnutrition-related disease are relatively high in Sub-Saharan Africa and South Asia, while life expectancy and adult literacy rates are relatively low. Similar patterns are evident in child stunting (low height for age) and wasting (low weight for height) (World Bank, 1993). The levels of these indicators are both consequences and, through their impact on labor productivity, potential causes of continuing pressure on natural and other resources in these regions (Dasgupta, 1993; Mink, 1993).

Implications for Sustainability and Food Security

The data presented in the previous section provide only a general sense of the ways in which resource indicators supplement indicators of food availability and access to provide a longer-term perspective on food security. Because of the close and reciprocal links between access to resources and access to food, it is difficult to devise a uniquely satisfactory scheme for distinguishing resource categories. Likewise, just as measures of food availability and access are insufficient to capture the notion of food security, it is impossible to equate any one resource indicator (or even any one resource category) with the notion of food security as a whole. In fact, food security is indicated not just by the quality of human resources, but rather by the extent and composition of all resources to which individuals, households, and countries have access.

The pitfalls of relying too heavily on any single resource indicator as a measure of food security are readily apparent. In Asia, for example, India and Bangladesh have the largest projected status-quo food gaps for 1997 (see statistical tables 43 and 44) and the highest shares of total land used as cropland (57 percent and 74 percent, respectively; World Bank, 1997a). The apparent correlation between these two indicators weakens in Sub-Saharan Africa, however, and fails entirely in Latin America and the Caribbean. Ethiopia and Rwanda have Sub-Saharan Africa's largest projected status-quo food gaps for 1997 (see statistical tables 10 and 13), but while Rwanda has the region's highest cropland-to-total land ratio (47 percent), Ethiopia's ratio (11 percent) is about average. Among Latin American and Caribbean countries, Haiti has one of the largest projected status-quo food gaps for 1997 (see statistical tables 57 and 61) and the second-highest cropland-to-total land ratio (33 percent), but Peru, where the food gap to maintain consumption is projected to reach half a million tons by 2007, has a cropland ratio of just 3 percent—less than half the regional average. Similar contradictions are apparent for other regions and resource indicators, suggesting the need for more sophisticated measures of the relationship between resources and food security.

One promising approach is to move beyond conventional quantity measures of individual resources, such as total land area (which is subject to wide variations in land quality), towards measures that reflect both the quality and quantity of multiple resources simultaneously. As noted previously, economists have begun trying to better incorporate changes in resource stocks into measures of national income and wealth. Table C-4 presents recent World Bank estimates of the contributions of different resource categories to wealth. Agricultural land accounts for most of the value of natural resources in most areas (Dixon and Hamilton, 1996). The share of total wealth represented by human resources is consistently high across regions, between 60 and 79 percent everywhere except in the Middle East, although total wealth varies widely. Estimates of genuine savings rates, which reflect changes in the value of human and natural resources, as well as produced resources, also vary widely (table C-1). Low genuine savings rates indicate the potential for deepening food security problems in some areas, particularly in Sub-Saharan Africa.

Such estimates are admittedly preliminary, but they offer interesting parallels between the analysis of resources and the analysis of food security. Just as the concept of food

Table C-4--Sources of Wealth

Region	Total wealth	Natural resources	Produced resources	Human resources	Natural resources	Produced resources	Human resources
	1,000 dollars per capita, 1994				Percentage of total wealth, 1994		
Sub-Saharan Africa							
East and Southern Africa	30	3	7	20	10	25	66
West Africa	22	5	4	13	21	18	60
East Asia	47	4	7	36	8	15	77
South Asia	22	4	4	14	16	19	65
Europe and Central Asia	na	na	na	na	na	na	na
Middle East and North Africa							
Middle East	150	58	27	65	39	18	43
North Africa	55	3	14	38	5	26	69
Latin America and Caribbean							
South America	95	9	16	70	9	17	74
Central America	52	3	8	41	6	15	79
Caribbean	48	5	10	33	11	21	69
High-Income Economies							
North America	326	16	62	249	5	19	76
Pacific OECD	302	8	90	205	2	30	68
Western Europe	237	6	55	177	2	23	74

na = not available.
Source: World Bank (1997b).

security has evolved in recent years from a relatively static focus on food availability to incorporate longer term concerns about access, so has interest grown in developing economic and environmental indicators that move beyond current income to reflect longer term changes in the quality and quantity of natural and other resources. While these two processes emerged from different concerns—the former primarily with hunger at the household and local levels, the latter largely with environmental degradation at the national and global levels—they are closely related.

Specifically, both represent components of an integrated problem in resource management, in which natural, produced, social, and human resources can be used in various ways to achieve a variety of objectives, including food security (World Bank, 1997b). At the core of this problem is the concept of sustainability. Serageldin (1996) distinguishes degrees of sustainability based on whether resources are seen as substitutes or complements to one another. "Strong sustainability" requires that each kind of resource remains intact, based on the assumption that resource categories are complements rather than substitutes. By contrast, "weak sustainability" maintains the total value of resources, regardless of its composition, implying that resource categories are substitutes rather than complements, and that individual resources (and even resource categories) can be depleted without threatening wealth as a whole.

Serageldin (1996) proposes a "sensible" middle approach that requires both the maintenance of total wealth and concern with the composition of wealth, recognizing that different resource categories are both substitutes and complements, and that critical levels of each category should be defined and maintained. Such a definition begins to sound very much like evolving definitions of food (and livelihood) security, which increasingly recognize the need to meet both food and non-food requirements in order to sustain human and other resources over time. In its shared attention to critical thresholds, tradeoffs, and sustainability over the long term, the convergence between these areas of research offers promise for improved understanding of the relationship between sustainable resource use and food security in the future.

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