3 !KUNG BUSHMAN SUBSISTENCE: AN INPUT-OUTPUT ANALYSIS[1]

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I. INTRODUCTION

THIS PAPER EXAMINES the ecological basis of a hunting and gathering economy through an input-output analysis of work and consumption. The first goal of this exercise is to outline the subsistence strategy that enables the !Kung Bushmen, with only the simplest of technologies, to live well in the harsh environment of the Kalahari Desert. The second goal is to show that the Bushmen exhibit an elementary form of economic life. And the third goal is to trace, from a primate baseline, the origin and evolution of human energy relations.

The methodology I have used is adapted from the transactional models of input-output economics (Leontief 1966) and ecological energetics (Gates 1962; Kleiber 1961). At the outset an essential

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distinction should be made between these two approaches. Ecologists take as their unit of study a species which has energy relations with other species within an ecosystem. A population is maintained by the energy absorbed in the course of food-getting activities of its members. The focus here is on *interspecific* trophic exchanges (Rappaport 1967:18–19). Economists, by contrast, focus on the exchange relations within a single species. A productive unit, such as an industry in the American economic system, is maintained by the inputs from other productive units, and in turn allocates its outputs to other like units or to the "final demand" sector of the economy (Leontief 1966:14–20). Viewed ecologically, these transactions can be considered as a highly evolved form of *intraspecific* exchange.

At first glance, the connection between, for example, the relations between predator and prey in an African savannah and the relations between industrial units in the American economy seems too remote to be worth considering. Yet this connection becomes meaningful when viewed in evolutionary terms. First of all, a human population, like all animal populations, has to expend energy in work in order to incorporate energy through consumption. In this respect energetics would apply equally well to the study of man as to the study of other animals.

However, in one important respect, human energy relations are unique among the higher animals. Whereas each adult non-human vertebrate organism is a self-sufficient subsistence unit, a large percentage of a man's energy expenditure goes to feeding others, and a large percentage of an individual's consumption is of food produced by others. Thus for humans, the minimal self-sufficient subsistence unit includes at least a social group, such as a family or "band," and at most includes economies involving hundreds of millions of persons. This central fact of cooperative consumption has been termed "division of labor" and "economic interdependence," and the study of the transactions and allocations so generated forms the foundation of economic science. In man alone, these intraspecific exchanges have become extraordinarily pervasive and complex, so much so, in fact, that we take them for granted! Yet it is precisely in this form of trophic exchange that animal adaptation and human adaptation first part company. And it is here that the study of energetics and economics converge.

In evolutionary terms the origin of what we call an economic system is a relatively recent phenomenon. It appears in the Pleistocene, probably less than two million years ago, when early man began to pool resources and thereby break down individual animal self-sufficiency. Women are usually thought to be the original "scarce good," or medium of exchange (White 1949:316; Lévi-Strauss 1949:35–86). It is more likely, however, that food was the original medium of exchange and that such exchanges are the foundation of social life.

Many economic transformations have occurred since the basic form of human exchange originated in the Pleistocene. Plant and animal domestication, the development of the market and money, and the harnessing of fossil and nuclear fuels have all contributed to making human energy exchange relations more complex.[2] The evolution of economic organization has reached the point at which an individual's productive activity is usually at the *n*th removed from the ultimate source of the food he consumes. He sells his labor (input) to the market and receives his consumption (output) in the form of cash, or some other convertible standard of value (Bohannan and Dalton 1962:9).

However, economies have evolved at different rates in various parts of the world. In some contemporary societies a much more elementary form of economic life can still be observed. I use elementary in the sense of an economy which exhibits the basic human pattern of exchange, without further elaboration.

In input-output terms, an economy exhibits an elementary form when the relation between the production and consumption of food is immediate in space and time. Such an economy would have the following properties: minimal surplus accumulation; minimal production of capital goods; an absence of agriculture and domestic animals; continuous food-getting activities by all able-bodied persons throughout the year; and self-sufficiency in foodstuffs and generalized reciprocity within local groups.

Although no contemporary society exhibits all these properties, the !Kung Bushmen of the Dobe area of Botswana are a close approximation. The !Kung have a simple, small-scale, self-contained economy of a type that may have been characteristic of

[2] The implications of these developments have been documented by Marx (1867), Childe (1951), Polanyi (1944, 1957), and White (1949, 1959).

early man. Extreme isolation and a marginal environment have been responsible for the persistence of this form to the present. The Dobe area is surrounded by waterless desert, and the Bushman population within it is largely self-sufficient in terms of subsistence. The economy lacks trading posts, trade in foodstuffs, wage labor, cash, conversions, and markets—the features which are commonly taken to indicate economic interdependence (Bohannan and Dalton 1962:1–26). Because the !Kung are hunters and gatherers, without agriculture and domestic animals (except for the dog), and because they do not amass a surplus of foodstuffs, the relation between local food production and consumption is an immediate one. A diagnostic feature of their subsistence economy is: *food is almost always consumed within the boundaries of the local group and within forty-eight hours of its collection.* This immediacy of consumption makes the !Kung Bushman an apt case for input-output analysis, since the level of work effort in a given period is a direct reflection of the food requirements of the local group. Such an analysis would be more difficult in a complex economic situation in which the work effort during a given period is dictated by the need for surplus accumulation for ceremonial purposes (Wolf 1966:7), for the conversion of subsistence goods into prestige (DuBois 1936), or for delayed consumption at a later period (Richards 1939:35–37).

Sections II through VI of this paper present the descriptive material on Bushman ethnography, demography, and subsistence strategies. These serve as a necessary introduction to the input-output analysis itself, presented in Sections VII and VIII. A concluding section (IX) returns to the problem of defining the properties of an elementary form of economy, and attempts to place the discussion in a comparative and evolutionary perspective.

II. ETHNOGRAPHIC BACKGROUND

The Dobe area lies in the northwestern corner of the Republic of Botswana and in adjacent areas of Southwest Africa. During my field work (1963–65), some 336 !Kung Bushmen were resident in the area, along with 340 Bantu pastoralists, mainly of the Herero and Tswana tribes.

!Kung Bushmen are known to have lived in the Dobe area

for at least 100 years. Late Stone Age materials of Wilton Horizon are found at several localities, indicating that some hunting peoples have lived there for many hundreds of years (Malan 1950). There is no evidence that the present-day !Kung are recent refugees from other areas (Lee 1965:38–68). The introduction of metal tools and weapons can be provisionally dated to the period 1880–90 when iron replaced bone as the primary material for arrowheads and spears.

The first European known to have penetrated the area was Hendrick van Zyl in 1879 (Silberbauer 1965:115). The Tswana cattle herders appeared soon after, and from the 1890s onwards the area was used as a regular summer grazing ground by these pastoralists. The first year-round settlements by non-Bushmen were not established until 1925 when two Herero families set up a cattle post at !angwa. Effective administrative presence is even more recent, dating from 1948, the year in which a resident Tswana Headman was appointed by the Paramount Chief of the Batswana Tribal Administration. Apart from brief annual patrols by the British Colonial government starting in 1934, almost nothing was known of the Dobe area until the 1950s.

In 1952, for example, Sillery wrote:

> Not far from the border of South West Africa, near latitude 20° south, is a group of caves which occur in the limestone there. These caves have been visited by few white people. The journey involves a long and arduous trek across sandy country through which no road passes and a competent guide is essential. . . . The country in the vicinity of these caves is probably the least known in the whole Protectorate and Bushmen and wild animals have it to themselves (1952:198).

The Marshall family of Cambridge, Massachusetts, were the first "Europeans" to spend more than a few weeks in this area. Their expeditions (1951–59) focussed on the adjacent Nyae Nyae !Kung in Southwest Africa and their reports form the most complete and detailed record for any Bushman group (Lorna Marshall 1957, 1959, 1960, 1961, 1962; John Marshall 1956; Thomas 1959).

In 1960, the South African government initiated a scheme to settle the !Kung Bushmen of the Nyae Nyae area. By 1964 over 700 Bushmen had moved into the government station at Tsumkwe S. W. A. and were being instructed in agricultural and stock-raising techniques. As a result of political pressures, the South Africans have not permitted the !Kung Bushmen of the formerly British Bechuanaland Protectorate to participate in this settlement scheme.

The situation in the mid-1960s finds the !Kung on the Botswana side of the border primarily dependent on hunting and gathering for their subsistence. The Bushmen have now obtained some blankets, clothing, and cooking utensils from their Bantu neighbors. There is an inexhaustible supply of metal for arrowheads which are hammered out from scraps of fencing wire from the cattle enclosures built by the Botswana Veterinary Department. However, the !Kung still lack firearms, livestock, and agriculture. About 7 per cent of the Bushwomen have married Bantu; and 20 per cent of the young men are working for Bantu as cattle herders. Serious disputes, usually involving Bush-Bantu labor relations, are adjudicated by the Tswana Headman. Capital offenders are sent to Maun, the tribal capital, for trial. European presence amounts to a brief patrol once every six to eight weeks. The important point is that the Bushmen continue to hunt and gather because there is no viable alternative available to them.

III. POPULATION DYNAMICS

In a census made in November 1964, the resident !Kung population stood at 336. Of the 336 residents, 248 were organized into fourteen independent camps, ranging in size from nine to twenty-nine members (see Table I). The size of each camp is a statistical abstraction because individuals and families were constantly shifting from camp to camp. Subsistence at the camps was based on hunting and gathering. The remaining eighty-eight residents were associated with Herero and Tswana cattle posts (Table IIa). These people did some work for the Bantu and ate some of their foods, including milk, cheese, and meat. Because part of their diet came from external sources, these Bantu-associated Bushmen groups are not included in the input-output analysis. In addition to the residents, fifty-five !Kung alternated

Table I Dobe area census by living units: resident camps

	Males			Females			Total			
No. place and name	Y*	A	O	Y	A	O	T	Effect.**	Dep	% Effect.
1. Dobe—n≠eisi	0	4	1	1	4	1	11	8	3	72.7
2. Dobe—≠oma//gwe	5	7	2	6	5	1	26	12	14	46.2
3. !angwa—bo	1	6	0	3	5	1	16	11	5	68.8
4. Bate—!xoma	3	7	0	3	5	1	19	12	7	63.2
5. Bate—Liceku	1	5	0	1	4	0	11	9	2	81.8
6. !ubi—Kamburu	3	5	0	1	10	0	19	15	4	79.0
7. !gose—/ise	1	7	0	5	7	2	22	14	8	63.6
8. !gose—/ilay	0	6	0	1	4	0	11	10	1	90.9
9. !gose—Konguroba	3	4	0	5	7	0	19	11	8	57.9
10. /ai/ai—//aunla	1	2	1	3	4	1	12	6	6	50.0
11. /ai/ai—//aiha	1	1	1	3	2	1	9	3	6	33.3
12. /ai/ai—≠omalxwa	4	9	1	3	10	2	29	19	10	65.5
13. /ai/ai—xlam	2	3	1	5	5	1	17	8	9	47.1
14. /ai/ai—≠omazho	4	6	2	6	8	1	27	14	13	51.9
Total in Resident Camps	29	72	9	46	80	12	248	152	96	61.3%

* Age Divisions: Y=Young, 0–15 years
A=Adult, 16–59 years
O=Old, 60+ years

** Effectives=Adults
Dependents=Young and Old

in and out of the Dobe area (Table IIb) and thirty-four others emigrated permanently from the area (Table IIc). Thus the grand total of Bushmen enumerated in 1964 was 425.

Table II Dobe area census by living units: other groups

	Males Y	Males A	Males O	Females Y	Females A	Females O	Totals T
IIa *Residents living with Bantu*							
21 living groups	11	27	2	9	38	1	88
IIb *Alternators*							
6 living groups	13	14	0	12	15	1	55
IIc *Emigrants*							
3 living groups	10	7	0	6	11	0	34
Total IIa, IIb, IIc	34	48	2	27	64	2	177
Grand Total of Population	63	120	11	73	144	14	425

In the census, the population is divided by sex, and by age into three divisions: young, 0–15 years; adult, 16–59 years; and old, 60+ years. Several important demographic features should be noted. Eight per cent of the population in camps (21 of 248) was determined to be over sixty years of age.[8] These data contradict the view that Bushman life expectancy is short. Silberbauer, for example, says of the G/wi of the Central Kalahari that "life expectancy among Reserve Bushmen is difficult to calculate, but I do not believe that many live beyond 45" (1965:17). Among the Dobe area !Kung, every camp had at least several members over forty-five years of age, and ten of the fourteen camps had members over sixty years old; the oldest person was estimated to be 82±3 years. These old people, although nonproductive in terms of food, played an important role in the social and ritual activities of the camps.

Since persons under fifteen and over sixty years of age do not contribute significantly to the food supplies of the camps, it is possible to use the census data to calculate the percentage of effective food producers and the percentage of dependents. The effectives comprised 61.3 per cent (152 of 248) of the total population in camps, in other words, every three effectives supported themselves and two dependents in subsistence. What is surprising is the wide variation in the percentage of effectives from camp to camp. In camp No. 11 (Table I), for example, three effectives supported themselves and six dependents (33.3 per cent effective), whereas in camp No. 8, ten of the eleven members (90.9 per cent) were effective. These variations were more apparent than real, however, since groups were constantly shifting in composition and the net effect was to produce work groups in which the ratio of effectives to dependents approached the mean.

[8] The age estimates are based on a relative age ranking of the population from youngest to oldest; an event calendar was used to establish birth dates. The accuracy of estimation is ± 3 years.

In addition, these data show an unusual sex ratio favoring females. In the total population, the sex ratio is eighty-four males per hundred females. The ratio for each age group is:

Young	86 males/100 females
Adult	83 males/100 females
Old	80 males/100 females

These data indicate a higher mortality rate for males in all age groups; although it is possible that the sex ratio at birth is anomalous, producing an initial excess of female over male live births. Another possible explanation is the practice of male infanticide. However, the overall incidence of infanticide (as well as invalidicide and senilicide) is so low that it is unlikely that this practice alone would account for the skewed sex ratio in the immature age group.

IV. SEASONAL SUBSISTENCE PATTERNS

The northern Kalahari Desert is characterized by a hot summer with a five-month rainy season from November to March, a cool dry winter from April to August, and a hot dry spring in September and October. During the spring and summer the diurnal temperature range is from a low of 60° F to a high of 100° F, with shade temperatures of as high as 108° F recorded. In the winter the diurnal range is from a low of 30° F to a high of 78° F. The annual rainfall varies from six to ten inches. The loose sandy soils support a surprising abundance of vegetation, in spite of the fact that the porosity of the sand is such that rainfall is rapidly absorbed and surface runoff is minimal. Permanent waterholes exist only where the underlying limestone strata have been exposed.

Because of these soil factors, the distribution of water sources is by far the most important ecological determinant of Bushman subsistence. The availability of plant foods is of secondary importance and the numbers and distributions of game animals are only of minor importance. Since the Bushman camps, of necessity, are anchored to water sources they can exploit only those vegetable foods that lie within a reasonable walking distance of water. Food sources that lie beyond a reasonable walking distance are rarely exploited.

The life of the camps surrounding the eight permanent waterholes are shown as solid dots on Figure 1. During the seven dry

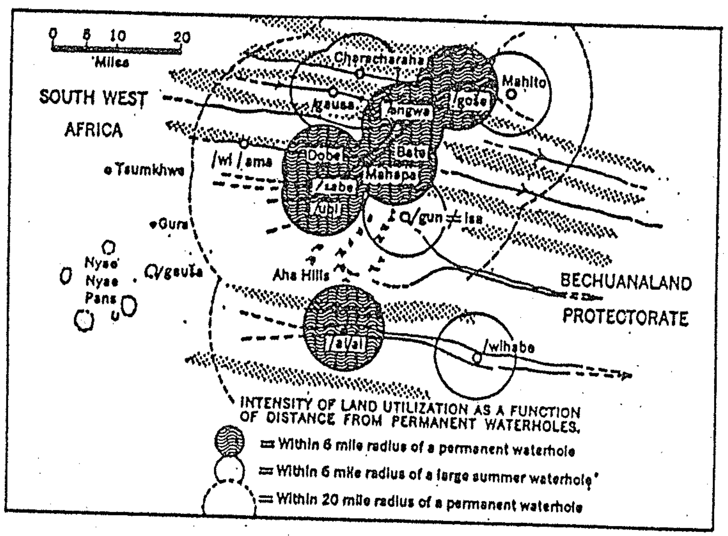

Figure 1 Intensity of land utilization as a function of distance from permanent waterholes

months of the year, April through October, these wells were the only sources of standing water and all the Bushmen camps were located within a mile of a well. During the summer rains (November–March) seasonal pools of water developed elsewhere, and virtually all the Bushmen went out to live at them.

The necessity for drinking water strictly defined the areas that people could exploit for food. On Figure 1 three divisions are plotted: (1) The shaded circles cover all the areas that lie within a day's walk, i.e., a six-mile radius, of a permanent waterhole. This area of about 600 square miles supports all of the 248 Bushmen in camps for half the year. Thus the effective population density for the dry season is 42/100 square miles. (2) The unshaded circles enclose an additional 400 square miles that lie within a six-mile radius of a large, seasonal summer waterhole. These areas support most of the resident population for the other half of the year. (3) Finally, the dotted line encloses all the areas that lie within a twenty-mile radius of permanent water. None of the Bushmen were observed to camp or forage *outside* of this dotted line, and in fact the additional areas, so defined, were rarely utilized by the Bushmen. Therefore about 1000 square miles was sufficient to support the entire population, plus visitors, at an effective density of 25 per 100 square miles, or four square miles per person.

Table III shows the actual numbers resident at each waterhole during the dry season of 1964. Two of the waterholes, !xabe and Mahopa, did not have an independent camp resident. The other six waterholes supported all of the 248 Bushmen in camps. The mean standing population per waterhole was forty-one and the range was from a low of sixteen at !angwa to a high of ninety-four at /ai/ai. These differences in standing population may reflect differences in the density of foodstuffs. It is probable that /ai/ai with ninety-four residents had more food closer to home than did !angwa, with only sixteen residents. Dobe with a standing population of thirty-seven was closest to the mean and was the subject of an intensive investigation of the relation of subsistence effort to food consumption.[4]

[4] The ecological and demographic determinants of group structure will be discussed in another paper.

V. PATTERNS OF CONSUMPTION

The camp serves as a home base for its members. Each morning some people move out to collect plant food and/or hunt game, and each evening the workers return to the camp and pool the collected resources with each other and with the members who stayed behind. Food getting is not a cooperative activity. Collectors go out in twos and threes and each woman gathers plant foods on her own. Hunters usually work individually or in pairs and the success of the hunt is dependent largely on an individual's tracking ability and on the enthusiasm of his hunting dogs; there is no evidence of coordinated effort producing more meat than individual effort.

Cooperation is clearly in evidence, however, in the consumption of food. Not only do families pool the day's production,

Table III The numbers and distribution of the resident Bushmen and Bantu by waterhole

Name of Waterhole*	No. of Camps	Population of camps	Other Bushmen	Total Bushmen	Bantu
Dobe	2	37	—	37	—
!angwa	1	16	23	39	84
Bate	2	30	12	42	21
!ubi	1	19	—	19	65
!gose	3	52	9	61	18
/ai/ai	5	94	13	107	67
!xabe	—	—	8	8	12
Mahopa	—	—	23	23	73
Totals	14	248	88	336	340

* For locations refer to Figure 1.

but the entire camp—residents and visitors alike—shares equally in the total quantity of food available. The evening meal of any one family is made up of portions of food from the supplies of each of the other families resident. Foodstuffs are distributed raw or are prepared by the collector and then distributed. There is a constant flow of nuts, berries, roots, and melons from one family fireplace to another until each person resident has received an equitable portion (cf. Marshall 1961). The following morning a different combination of foragers moves out of camp and, when they return late in the day, the distribution of foodstuffs is repeated. Except in the case of windfalls, such as the killing of a large ungulate, food rarely moves beyond the boundaries of a camp. People, however, move frequently from one camp to another. The boundary of the camp, therefore, can be considered to define the boundary of the co-consuming group; and the size of the consumption unit will depend on the number of personnel on hand in a given day.

The food resources of the Dobe area were both varied and abundant. I tabulated over 200 plant and 220 animal species known and named by the Bushmen (Lee 1965:98–121). Of these, eighty-five plant species and fifty-four animal species were classified by the Bushmen as edible. The basic food staple is the mongongo (mangetti) nut, *Ricinodendron rautanenii Schinz;* alone it accounted for one-half to two-thirds of the total vegetable diet by weight. This species was so abundant that millions of the nuts rotted on the ground each year for want of picking. The energy yield of the nut meat is remarkably high: 600 cals./100 gms. (see Section VIII below).

Of the fifty-four animals classified as edible, only ten species of mammals were regularly hunted for food. The ten species, listed in order of their importance in the diet, are: wart hog, kudu, diuker, steenbok, gemsbok, wildebeeste, spring hare, porcupine, ant bear, and common hare.

VI. FORAGING STRATEGY

The Bushmen were observed to be highly selective in their food habits. They stated strong likes and dislikes in foods and all of the eighty-five edible species of vegetable food were clearly ranked by the Bushmen on criteria of desirability: tastiness, nutritional value, abundance, and ease of collecting. As a rule people tended to eat only the most palatable and abundant foods available and to bypass the less desirable foods. Since the other major factor in subsistence was the distance between food and water, it is possible to summarize the basic principle of Bushman foraging strategy in a single statement: *At a given moment, the* *members of a camp prefer to collect and eat the desirable foods that are at the least distance from standing water.*

Given this principle, the optimum situation occurs when standing water and mongongo nuts are close together, and the worst situation occurs when water and nuts are far apart. The dynamics of the subsistence situation are made clear when we realize that the food that can be eaten in one week is a function of the food that has already been eaten in previous weeks.

The Bushmen typically occupy a camp for a period of weeks or months and eat their way out of it. For instance, at a camp in the nut forests (which form narrow belts along the crests of fixed dunes, see Figure 1), the members will exhaust the nuts within a one-mile radius during the first week of occupation, within a two-mile radius the second week, and within a three-mile radius the third week. As time goes on, the members of the group must travel farther and farther to reach the nuts, and the round-trip distance in miles is a measurement of the "cost" of obtaining this desirable food.

In Figure 2, the cost of obtaining mongongo nuts is plotted

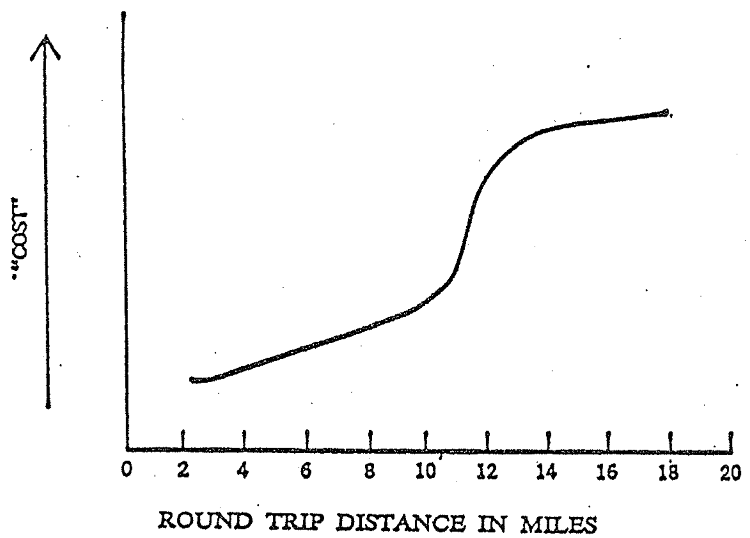

Figure 2 The cost curve for obtaining mongongo nuts

against distance. The cost curve for nuts rises slowly as the round-trip distance increases from two to twelve miles, climbs sharply from twelve to sixteen miles, then levels off for longer distances. The reason for the inflection in the cost curve is the difference between one-day trips and overnight trips. A round trip of up to twelve miles can be accomplished in a single day, but for trips to more distant points an overnight hike must be organized, involving the packing of drinking water and the carrying of heavy loads over long distances.

The alternative tactic to the longer trips is to stay at the home base, and to exploit foods of lesser desirability in terms of taste, ease of collecting, and abundance. At a given dry season camp one sees both alternative tactics in evidence. The older, less mobile members of the camp stay close to home and collect the less desirable foods, while the younger, more active members make the longer trips to the nut forests. As the water—nut distance increases, more and more attention is given to the lesser foods.

During the rainy season, a different and less costly strategy is employed. Since temporary pools of water form at a number of localities, when nuts are exhausted within a few miles of one pool the entire group moves camp to another where water and nuts are still abundant. Thus the "cost" of obtaining nuts during the rainy season never exceeds the level of a six-mile round trip. Towards the end of the rainy season, a temporary pool may dry up before the nuts in its immediate vicinity become exhausted. In this case the residents move camp to one of the large summer waterholes which usually persist until early autumn (April or May). When these latter pools dry up, then the entire population moves back to the areas around the eight permanent waterholes to spend the winter and spring dry season.

It is evident that the crucial factor in the annual subsistence cycle is the distance between food and water. Basically, the Dobe area !Kung face three different sets of conditions through the year.

(I) Food Abundant and Many Water Points

During the rainy season (November–April) all the people live at the temporary pools in the midst of the nut forests. The water–food distance is short and the subsistence effort is minimal. This is also the season of plant growth when seasonal foods such as berries and leafy greens are available.

(II) Food Abundant but Only Eight Water Points

In the early half of the dry season (May–July), all the groups are based at the permanent waterholes. They eat out an increasing radius of desirable foods. As the water–food distance increases, the subsistence effort increases.

(III) Food Scarce and Only Eight Water Points

By the end of the dry season (August–October) the water–food distance approaches an annual maximum. People must either walk long distances to reach the nuts, or be content to eat the less and less desirable foods, such as bitter melons, roots, Acacia gum, and the heart of the vegetable ivory palm. The diet is most eclectic at this time of year.

With the onset of the first rains in late October or November, a new cycle of plant growth is initiated and seasonal pools again form in the hinterland. The subsistence effort decreases to the level of condition I.

VII. INPUT-OUTPUT: THE SUBSISTENCE EFFORT

As stated earlier, the purpose of Bushman work is to get food, and the amount of work expended is therefore a measure of the effort required to feed the group. In addition, the food gathered is equitably distributed among all members of the camp and rarely moves beyond camp boundaries. With these points in mind, we can apply the framework of input-output analysis to the Bushman data. The work input, or subsistence effort, is a compilation of all the days of work carried out by members of a group within a specified period of time. The subsistence effort could be stated in terms of the number of work days per week per hunter or gatherer. This, however, is a crude measure, since it does not define the size of the consumption unit. In addition one should know the number of dependents who are being supported by the work. The consumption unit, therefore, is defined by adding together the total number of effectives and the total number of dependents resident at a camp during a specified period.

I have found useful the following formula for measuring "S," the index of subsistence effort:

$$S = \frac{W}{C}$$

where W = the number of man-days of work and
where C = the number of man-days of consumption.

Example 1 Consider a hypothetical population of ten people subsisting for a thirty-day period. Since everyone eats every day, the value of "C" (man-days of consumption) is:

$$C = 10 \times 30$$
$$= 300$$

How many man-days of work will be necessary to provide 300 man-days of consumption? If every person worked every day of the thirty-day period, then:

$$W = 10 \times 30 \quad \text{and} \quad S = \frac{W}{C}$$
$$= 300 \qquad\qquad = \frac{300}{300}$$
$$= 1.00$$

Since every person works every day in order to eat every day, the value of "S" is unity.

Example 2 If everyone worked on alternate days, then:

$$S = \frac{10 \times 15}{300}$$
$$= .5$$

Example 3 If half the people worked every day and half the people were dependents, then:

$$S = \frac{5 \times 30}{300}$$
$$= .5$$

Example 1, in which everyone works every day, is not merely a hypothetical case. In fact, "S=1.00" approximates the situation among the non-human primates (and most other vertebrates) in which every animal (save nursing infants) forages for its own food on every day of the year. For monkeys and apes (DeVore 1965) the value of "S" approaches unity and the actual value of "S" is simply a function of the percentage of nursing infants in the population.

A baboon troop, for example, leaves the sleeping area each morning and spends the day moving as a group through its range (Hall and DeVore 1965:70). Although the spatial cohesion of the group is maintained, each troop member acts as a self-sufficient subsistence unit, collecting and eating its own foods as it moves. There is no *exchange* of food between individuals, and this is truly a "hand-to-mouth" existence. The foregoing is not meant to imply that subsistence is precarious for baboons and other primates. On the contrary, the individual animal may spend only a few hours a day picking food, and this activity is interspersed with periods of social grooming, sexual and dominance behaviors, and sleeping. The point is that the work rhythm is such that every individual must do some subsistence work on *every single day of his adult life.*

The work rhythm of human groups is radically different. All human societies allocate some days to work and others to leisure, and in all human societies some people work harder than others. However, the condition "S=1.00" can be regarded as the baseline from which man evolved. The sharing of food is part of a cluster of basic human institutions which also include the division of subsistence labor, the home base, the primary carrying device (for transporting foods to the home base for distribution), and the prolonged support of non-productive young and old people. These developments represent a quantum step in human affairs, for their presence means that not *all* of the people have to work *all* of the time.

The immediate implication of division of labor was that the value of "S," the index of subsistence effort, must have dropped radically during the early phases of hominid evolution. It is at this point that human economics parts company with animal energetics. The long-term implications of division of labor are manifold. Exchange opens up the possibility of more and more complex forms of surplus accumulation, either for the purpose of distribution to a wider social group or for the purpose of con-

sumption by the producers themselves at a later date. Therefore one of the important dimensions along which economic evolution can be traced is the increasing separation between the production of food and its allocation to consumers.

Formally, the !Kung Bushmen economy corresponds to an early stage in this trend since the relation between production and consumption of food is immediate in space and time. Food produced by the local group is consumed within its boundaries, usually within forty-eight hours of production. The major concern, therefore, is to use the formula $S = \frac{W}{C}$ for the analysis of !Kung subsistence.

In any self-sufficient human group the magnitude of "S," the subsistence effort, is a function of the ease or difficulty of feeding the group. One would assume that hunter-gatherers such as the !Kung Bushmen, with a simple technology, living in a marginal desert environment, would have a difficult time getting food; therefore the index of subsistence effort should be relatively high.

For instance, in a group of ten people, if the six adults had to work 5½ days per week to support themselves and four dependents, then the value of "S" would be ca. .5. A 5½ day work week is not excessive by Western industrial standards. On the other hand, if the work week were only three days long, then the value of "S" would fall to .26.

The calculation of the actual level of subsistence effort is, of course, an empirical question. Table IV tabulates the four-week work diary for the Dobe camp during the period July 6 to August 2, 1964. This period was chosen because it was neither the easiest nor the most difficult time of the year for subsistence, and it covered the period of transition from better to worse conditions.

Column (1) shows the number of adults at the camp on each day and column (2) the number of children. Column (3) tabulates the number of man-days of consumption (and incidentally documents the daily variations in group size). Column (4) counts the number of people who went out for food each day. Column (5) lists the meat output, in pounds of edible raw portion, for each day.

Table IV Dobe work diary: a record of the activities at the Dobe camp for the 28-day period 6 July–2 August, 1964

Week	Date	(1) Adults	(2) Children	(3) Man-days of consumption*	(4) Man-days of work	(5) Meat output pounds
	July 6	18	9	27	9	—
	7	14	9	23	6	92
	8	15	9	24	2	—
I	9	15	9	24	3	12
	10	16	9	25	7	—
	11	18	11	29	3	—
	12	18	9	27	7	—
	13	20	11	31	5	—
	14	16	9	25	0	—
	15	16	9	25	1	—
II**	16	14	9	23	0	—
	17	19	12	31	11	80
	18	17	9	26	3	—
	19	23	14	37	2	—
	20	26	14	40	9	110
	21	24	11	35	3	24
	22	19	13	32	3	—
III	23	18	11	29	4	27
	24	23	13	36	10	16
	25	22	10	32	6	—
	26	24	12	36	7	—
	27	22	13	35	12	7
	28	27	13	40	12	80
IV	29	26	13	39	9	10
	30	24	11	35	16	12
	31	22	10	32	4	20
	Aug. 1	24	11	35	8	—
	2	22	11	33	16	—

* Each entry in column 3 equals the sum of the entries in columns 1 and 2 for the given date.

**Week II (July 13–19) shows an unusually *low* work output. The investigator contributed food on July 12 and 17, resulting in a decreased subsistence effort for the seven-day period. Week II therefore has not been included in final calculation of the S ratio (see Table V).

Table V is a summary, by week, of the work diary. Mean group size (column 1) varies from 25.6 to 35.6; the actual count of personnel on hand was rarely the same two days running. The work week (column 7) varies from 1.2 to 3.2 work days per adult. In other words, each productive individual supports herself or himself and dependents and still has 3½ to 5½ days available for other activities. The Index of Subsistence Effort (column 8) varies from .11 to .31. For instance, during Week I (July 6–12), thirty-seven man-days of work were expended to provide 179 man-days of consumption. The value S=.21 indicates twenty-one days of work per hundred man-days of consumption; or each day's work provided food for the worker and four other people. During Week IV (July 27–August 2), seventy-seven man-days of work provided 249 man-days of consumption for an "S" value of .31 (31 work days per 100 consumption days). The work input during Week IV is 50 per cent higher than in Week I. This rise reflects an increased difficulty in reaching food, although, in terms of actual time devoted to the food quest, the average rises from two days per week to three per week per individual producer.

In calculating the overall average value of "S" for this period, I have omitted Week II for the reason noted (Table IV, note 2); therefore the Index of Subsistence Effort for this camp of !Kung Bushmen is .23. Since the non-productive members comprised 35 per cent of the population, another way of expressing the Index is to say that 65 per cent of the people worked 36 per cent of the time, and 35 per cent of the people did no work at all.[5]

Two of the ecological conditions noted above are represented in the work diary. The first week is condition II, in which food is abundant but only eight water points are available. People are making the daily round trips to the nut forests, giving an "S" value of .21. By the fourth week condition III has appeared; it is no longer possible to reach the nuts in one day, since a radius of over seven miles has been eaten out. The round-trip distance

[5]In calculating the Index, I have taken into account only the work actually devoted to getting food. The time spent on manufacturing the tool kit has not been included, nor has the time spent on processing food. However, in calculating the caloric requirements (Section VIII), I have included a value for the energy expended in such activities.

Table V Summary of Dobe work diary

Week	(1) mean group size	(2) adult-days	(3) child-days	(4) total man-days of consumption	(5) man-days of work	(6) meat lbs.	(7) work week	(8) Index of Subsistence Effort
I (July 6–12)	25.6 (23–29)	114	65	179	37	104	2.3	.21
II (July 13–19)	28.3 (23–37)	125	73	198	22	80	1.2	.11
III (July 20–26)	34.3 (29–40)	156	84	240	42	177	1.9	.18
IV (July 27–Aug. 2)	35.6 (32–40)	167	82	249	77	129	3.2	.31
4-wk. Totals	30.9	562	304	866	178	490	2.2	.21
Adjusted* Totals	31.8	437	231	668	156	410	2.5	.23

* See note** in Table IV

KEY: Column 1: mean group size = $\frac{\text{total man-days of consumption}}{7}$

Column 7: work week = the number of work days per adult per week

Column 8: Index of Subsistence Effort = $\frac{\text{man-days of work}}{\text{man-days of consumption}}$

(e.g., in Week I, the value of "S" = .21, i.e., 21 days of work per 100 days of consumption or 1 work day produces food for 5 consumption days)

to the nearest nuts is over fourteen miles and the "cost" curve of nuts has turned sharply upwards (see Figure 2). The higher value of "S" (.31) reflects the marked increase in overnight trips to reach the nut forests.

VIII. INPUT-OUTPUT: CALORIC LEVELS

Having considered the level of work effort required to feed the group, it is necessary to determine the quantity of energy yielded by this work effort. Since the actual time devoted to subsistence is modest, the question arises whether this low work effort produces a substandard diet.

The major constituents of the diet by weight during this period were:

1.	mongongo nuts	33%
2.	meat	37%
3.	other vegetable foods	30%
		100%

During field work no direct caloric observations were made. It was difficult to measure a single individual's daily food intake, since this was eaten over a period of several hours in the late afternoon and evening and was made up of small portions from the supplies of different families. However, since foodstuffs are shared equitably throughout the camp, it was possible to measure gross per capita intake by estimating the total weight of food brought in and dividing it by the number of people on hand. A net per capita intake figure was calculated by deducting values for waste (inedible portions, bones, nutshells, etc.) and allowing for loss through cooking. An account follows of the methods and results.

1. The staple mongongo nut is particularly suitable for this kind of analysis; it is easy to count and weigh, and the percentage of edible constituents is precisely known. The nut consists of a hard outer shell and a soft inner shell (both inedible) and a core of edible nut meat. The whole nut weighs 5.0 gm. and the nut meat comprises 14 per cent of the total weight, or 0.7 gm. (Anon. 1917; author's field observations).

There are approximately 200 whole nuts per kilogram (91 nuts per lb.). Each kilogram of whole nuts yields 140 gm. of nut meats (64 gm. per lb.). I weighed the total back load of nuts brought in by a sample of women each day. A woman's daily collection of whole nuts weighed between 10 kg. (22 lbs.) and 15 kg. (33 lbs.), although back loads of as much as 20 kg. (44 lbs.) of whole nuts were recorded. Each back load contained on the average 2500 whole nuts, as well as smaller quantities of other foodstuffs. Since the edible portion of whole nuts is 14 per cent, each 12.5 kg. back load of nuts contained 1750 gm. of edible nut meats.

Records were also maintained for the number of nuts cracked and eaten by individuals and families on a single day. Women roast a quantity of nuts in the coals of the fire for a few minutes before cracking. The nuts are equally palatable when raw, but the brief roasting serves to drive off some of the moisture and makes the hard outer shell easier to crack. The nut is then cracked open, using a fist-sized limestone cobble as a hammerstone and a larger flat limestone block as an anvil. The shell is extremely hard, which accounts for the remarkable storage properties of the mongongo. Nuts are still perfectly edible after having lain on the ground for a year.

The cracking and shelling rate averages five or six nuts per minute and varies little from one woman to another. In one hour a woman cracks and shells 300–360 nuts, or one-eighth of a back load, and an hour's cracking yields 210–252 gm. of edible nut meats. On the basis of observations of cracking rates and time devoted to cracking, and on the basis of total weights of whole nuts brought into the camp, Bushmen were observed to eat about 300 nuts per person per day, yielding 210 gm. of nut meats. Thus one back load of whole nuts would feed a family of four for two days, with a little left over for the third day.

The constituents of the nut meat have been determined (Wehmer 1931, vol. 2:678)[6] and the nutritional yield can be calculated (Oser 1965:1336).[7] The yield is 600 (±1 per cent) cal. per 100 gm. of edible portion and the protein yield 27 gm. per 100 gm. The caloric value of mongongo compares favorably with

[6] Fats 59.4%, Protein 27.0%, Crude Fiber 5.9%, Water 4.7%, Ash 3.02%.
[7] Modified Atwater formulas used by the F.A.O. were employed, based on the following values: 8.37 cal./gm. of fat, 3.4 cal./gm. of protein.

that of domesticated species of nuts such as almonds (600 cal. per 100 gm.), brazil nuts (653), cashews (563), and peanuts (583). In proteins, however, it exceeds the levels for these other nuts (27 per cent for mongongo vs. an average of 19 per cent for other species).

2. Complete records were kept for kills of game animals, and for the quantities of meat brought into the Dobe camp during the twenty-eight-day period of the work diary. Eighteen animals, totalling 206 kg. (454 lbs.) of edible meat, were killed and consumed by members of the camp.[8] In addition, 16 kg. (36 lbs.) of meat were brought into Dobe by visitors from other camps, for a total of 222 kg. (490 lbs.) of meat. Dividing this figure by the 866 man-days of consumption (see above) gives a daily allotment of 256 gm. (9.1 oz.) of uncooked meat per person. Even allowing for a 10 per cent shrinkage in cooking, the caloric yield of this allotment is estimated at 690 calories (based on a rate of 300 cal. per 100 gms., cooked). The protein content is estimated to be 15 per cent by weight, or 34.5 gms. per cooked portion.

3. The remaining vegetable portion of the diet consisted of small quantities of twenty species of roots, melons, gums, bulbs, and dried fruits. No caloric observations were made for these foods and their total caloric yield is estimated at 100 cal. per 100 gm. Protein yield is negligible, and is estimated at 1 per cent.

In Table VI the three main food sources (meat, mongongo nuts, other vegetable foods) are brought together in order to show the contribution each makes to the Bushman diet and to derive an estimate of daily per capita intake of calories and proteins. The results show a daily allotment of 2140 calories and 93.1 grams of proteins per person. Because of the high protein values for mongongo, the protein intake is unusually high even by American standards. It is also unexpected that a hunting people should get such a high proportion of their proteins from vegetable rather than from meat sources.

Does a per capita intake of 2140 calories meet the energy requirements of the group? The Bushmen are small in stature and

[8] Edible/waste ratios for various mammals were calculated by R. H. S. Smithers.

weight. The average height and weight for adult males are 157 centimeters (5ft. 2 in.) and 46 kilograms (101 lbs.) and for adult females 147 centimeters (4ft. 10 in.) and 41 kilograms (91 lbs.) (Bronte-Stewart et al. 1960). Basal metabolic requirement for individuals of such heights and weights are calculated

Table VI Caloric and protein levels in the !Kung Bushman dietary, July–August, 1964

Class of food	Percentage Contribution to Diet	Per Capita Consumption Weight in grams	Per Capita Consumption Protein in grams	Calories per person per day
meat	37%	230	34.5	690
mongongo nuts	33%	210	56.7	1260
other vegetable foods	30%	190	1.9	190
Total, all sources	100%	630	93.1	2140

at 1400 cal. per day for males and 1100 cal. per day for females (Taylor and Pye 1966:45–48). Given an activity regime that varies from light–moderate to severe exercise (including an hour of nut-cracking per day and two ten-mile hikes per week), the caloric requirements can be estimated at 2250 calories for males and 1750 calories for females, per day of an average work week. These figures apply to adults thirty years of age and would necessarily be less for middle-aged and elderly persons. For children I have taken a median age of eight years for all individuals under age fifteen and estimate the daily requirements at 2000 calories (Taylor and Pye 1966:463).

To calculate the daily caloric requirement for the study group as a whole, it is necessary to take an average weight according to the percentage of each age-sex class in the population. Since the population consists of 30 per cent adult males, 35 per cent adult females, and 35 per cent children under fifteen years (see Tables I and II), the mean daily energy requirement for a group of thirty-one persons is 61,300 calories, and for each group member, about 1975 calories.

The per capita yield of foodstuffs during the study period

was estimated to be 2140 calories (Table VI) and therefore it is clear that food output exceeds energy requirements by about 165 calories per person per day. The conclusion can be drawn that the Bushmen do not lead a substandard existence on the edge of starvation as has been commonly supposed.[9]

A portion of these extra calories is absorbed by the food allocated to the maintenance of hunting dogs. The dog population of Dobe varied from five to eight animals. The dogs eat what is left over when people have eaten their fill, and it is worth noting that the physical condition of the animals seemed to show more seasonal variation than the conditions of the humans. It may be possible that, in input-output terms, Bushman dogs absorb most of the marginal variation in abundance of foodstuffs brought into the camp.[10]

The remainder of the extra calories may go into physiological accumulation of fat by the Bushmen during the good season, an accumulation which is then metabolized during the worst season of the year (September–October). Future research should include the weights and skin-fold measurements of individuals taken each month through the annual cycle. During the lean season of the year, the availability of the staple mongongo nut reaches an annual low, and the people have to walk farther and work harder in order to maintain an adequate diet. In other words, a higher energy input yields a relatively lower caloric output.

The significance of the differential activities of young and old people can now be appreciated. The more able, more mobile members of the group have higher energy requirements and they have the means to meet these by making the long hikes to the mongongo nut forests. The old people, with more modest energy requirements, remain close to home and gather a more eclectic diet

[9] The possibility that the Bushmen were enjoying an exceptionally good year can be discounted. The observations were made during the second year of a severe drought, which seriously dislocated the pastoral and farming economics of the Bantu, but apparently did not seriously affect the foraging economy of the Bushmen. If drought conditions demanded a three-day work week from the Bushmen, then one would have to postulate an even lower work input during years of average or higher rainfall.

[10] Pigs may play a similar role in the subsistence economy of Melanesians (Vayda et al. 1961; Rappaport 1967). Unlike the Melanesians, who eat their pigs, the Bushmen have never been known to eat their dogs.

of low-yield roots, bulbs, and edible gums. The group as a whole distributes the collective resources in such a way that the caloric needs of each age-sex class are met. In input-output terms this is a way of restating the classic dictum: *from each according to his means and to each according to his needs*. In principle the Bushman camp is a communistic society. In practice, sharing is never complete, but conflicting parties have the option of rearranging themselves spatially so that, when sharing breaks down, new groups can be constituted to ensure parity of production and consumption.

The input-output approach to subsistence has shown that !Kung Bushmen in the Dobe area can derive an adequate living from only a modest expenditure of their time and effort. The analysis may help to correct the impression that their life is a constant struggle, maintained in the face of adversity, and ending in early death. As Sahlins (1968:85–89) has pointed out in a recent discussion, our view of the hunter has been conditioned by the traditional wisdom of the economics of scarcity. We have tended to equate poverty with the absence of material wealth. Sahlins suggests the alternative interpretation that hunters may be simply in business for their health, and that this modest end can be achieved even with the rudimentary technical means at their disposal. The result is that hunters may actually enjoy more leisure time per capita than do peoples engaged in other subsistence activities (see also Service 1966:13). In the Bushman case, food-getting is the primary productive activity, but the majority of the people's time (four to five days per week) is spent in other pursuits, such as resting in camp or visiting other camps.

Since the northern Kalahari Desert is by any account a marginal habitat for human occupation, it is likely that hunters in the past would have had an even more substantial subsistence base. Today the remaining hunters are confined to the least attractive environments of the world, but in Pleistocene times they would have had their pick of the richest areas, in terms of game, plant foods, and water supply.[11]

[11] The reconstruction of the prehistoric habitats of hunter-gatherers has been discussed in detail elsewhere (Lee 1963 and 1968).

IX. ELEMENTARY FORMS AND THE LOGIC OF GENERALIZED RECIPROCITY

One of the most striking cross-cultural regularities yet discovered is the almost universal practice of voluntary food sharing among small-scale hunter-gatherers.[12] Sahlins has labelled this practice generalized reciprocity, and defines it as the giving of food, or other goods, without a definite expectation of return (1965:147). It is the kind of transaction that obtains in our own society between members of the nuclear family, and it falls at the solidary (sociable) extreme of Sahlins' continuum of reciprocities, ranging from generalized, through balanced, to negative reciprocity, the latter being the unsociable extreme (1965:147–49).

Viewed as a system of allocations, generalized reciprocity may be a necessary sociological outcome of the elementary form of economic life defined in Section I of this paper. The clue lies in the implications of this practice for the organization of subsistence. The obverse of sharing is, of course, hoarding, or withholding. The latter is reported to be a cardinal sin among hunter-gatherers (Service 1966:18; Sahlins 1965:200–1, 215–18). Yet hoarding is but a morally negative paraphrase of the respectable economic term "surplus accumulation." The act of setting aside a portion of one's production for consumption or distribution at a future date is the essence of bourgeois economics ("savings"), but it is regarded as stinginess or hard-heartedness among the hunters. Since everyone in a hunter camp must be fed from the food supply on hand and since no one can be refused, the constancy of demand tends to keep food inventories at a minimum. It also tends to maintain "wealth" differences between people at an exceedingly low level. Constant turnover and low inventories are simply different facets of the earlier definition of an elementary form as an economy in which food production and consumption are immediate. In such an economy, the withholding of

[12] Some of the evidence has been brought together by Sahlins in his excellent review on reciprocity (1965:186–91, 200–1, 215–18). The practice of generalized reciprocity within local groups is found among: Mbuti Pygmies, Andaman Islanders, Australian Aborigines, Eskimos, Semang, and Great Basin Shoshone. For references consult Sahlins (*op cit.*).

food by even one party would be incompatible with the model of generalized reciprocity. Only if all parties are equally wealthy—or, to be more accurate—equally poor, can the economic equilibrium be maintained.

What would happen if one individual in such an economy, against the expectations of his fellows, were to husband his resources and allocate his production to savings rather than to sharing? The short-term result of such a move would probably be ostracism for the individual; but if enough of his fellows were able to follow his example and did so, then the social fabric would be preserved and a new economic equilibrium would be established at a higher level of surplus accumulation. Wealth disparities would now become possible, and an avenue for the conversion of subsistence goods into prestige would open up. Such a society would have embarked on the road to "economic development."

In human energy relations, no individual is self-sufficient. Human existence is made possible by the work effort of individuals, but social life is founded upon the principle of cooperative consumption of resources. It is fortunate for anthropologists that in some contemporary societies, the rudimentary forms of exchange may still be observed. In other societies higher orders of complexity can also be observed, enabling the analyst to trace the evolution of economic systems.

Starting from the primate baseline of a "hand-to-mouth" existence, one can discern several secular trends in human social evolution. One such trend leads to an increasing separation between the production of food and its final allocation in consumption. Another is in the direction of conversion of an increasing proportion of subsistence output into the production of durable goods. And a third trend is towards a greater and greater disparity in the distribution of wealth among individuals.

On all of these dimensions, the !Kung Bushmen exhibit an elementary form. Although the ideology of exchange is complex, the formal aspects of exchange are simple. Using input-output analysis may contribute, on a quantitative level, to our understanding of the origins and evolution of economics.

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