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Social Adaptation to the Mountain Environment of an Andean Village

William P. Mitchell

Monmouth College, West Long Branch, New Jersey, USA

Over the past several years it has become increasingly apparent that social adaptation to a complex eco-setting is of fundamental importance to understanding central Andean society. The native civilizations of this area evolved in the context of this environment. The contemporary Quechua- and Aymara-speaking inhabitants of the highlands continue—albeit with modification—many of these aboriginal ecological adaptations. Consequently, a knowledge of contemporary adaptations can elucidate the process of state formation in this area (Mitchell, 1976a, 1976b). Moreover, since these ancient civilizations were primary states, i.e., they evolved independently of other states (Lanning, 1967; Lumbreras, 1974; Patterson, 1973), the knowledge gained will increase our understanding about the evolution of civilization in general.

The central Andes is characterized by three broad geo-environmental divisions: the desert coastal plain, the semi-arid highlands, and the montaña or tropical rain forest of the eastern Andean slopes. In addition, each of these regions is diversified internally. Of particular interest in the evolution of Andean society is the ecological setting of the highlands. Here a large sampling of the world's major ecological zones is arranged vertically along the mountain slopes. Within a short span one may travel from a warm sub-tropical valley to a cold alpine tundra.

A major focus of recent research has been the study of a unique and important feature of the Andean adaptive pattern known as the exploitation of vertical archipelagos (Murra, 1968, 1972). In this adaptive strategy, aboriginal civilizations maintained political control over discontinuous areas in different eco-zones, sometimes separated by several hundred miles, in order to exploit the products of these zones. Our knowledge of this pattern has been extensively documented by Murra's ethnohistoric research. Although found in a diminished way in many local communities today, where for example, highland communities possess parcels of land in the tropical forest montaña, the most complex manifestations of this adaptive pattern disappeared after the Spanish conquest (Fonseca, 1972).

A separate, although not exclusive, adaptive strategy in the highlands has been the exploitation of vertical eco-zones found over a continuous area. This

pattern persists in many contemporary communities (Gade, 1975; Mitchell, 1976a, 1976b; Rhoades and Thompson, 1975; Thomas, 1973; Arnold, 1975; Brush, 1976; Custred, 1973; Fonseca, 1972; Vallee, 1971; Webster, 1971). In some cases the number of eco-zones exploited is very few, while in others it is quite extensive. However, the extent of the relationship between the vertical ecology and the organization of a contemporary local community has only begun to be intensively documented. This paper represents a preliminary step in this direction by focusing on the role of altitude-determined environmental zones in the organization of Quinua, a community in the central Peruvian highlands. For reasons of space, much of the argument is presented in outline. More detailed reports are in preparation (Mitchell and Arnold; Mitchell). Nonetheless, as will be explicated below, the data from Quinua indicate that land use and productive organization are directly related to the mountain ecology. Land use, in turn, affects such social features as land tenure, settlement pattern, population density, barrio organization, and social stratification.

LOCATION AND SETTING

Quinua is a Peruvian district located to the northeast of the city of Ayacucho on the western slopes of the range of mountains forming the eastern wall of the Ayacucho Valley (Fig. 1). The elevation of the central town is slightly less than 3396 m. The town is located at latitude 13°03' and longitude 74°8'. The topography of Quinua, as in much of the highlands, consists of gentle slopes interspersed with numerous deep and rugged ravines and gorges. These provide drainage during the rainy season. Cultivated terrain is generally found on the slopes, although land may be sown at the bottom of some of those larger ravines which do not flood during the rainy season.

Quinua consists of a central town, surrounded by rural hamlets and dispersed settlements. The town is the administrative and ceremonial center of the district. In addition, the district is divided into geo-political units or hamlets known as *pagos*. The center of a hamlet is usually a small nucleated village. In addition to its center, every hamlet is divided

into localities (*sitios*) that pertain to it for administrative purposes. Hamlets and localities are usually delineated by features of the terrain such as ravines and steep mountain slopes.

Quinua is an independent community (i.e., relatively free of hacienda control) in which most people own their own lands. Except for a small ruling group of townsmen, and recently educated young people, most of the population of 5348 people consists of Quechua-speaking peasants (*campesinos*) (Mitchell, 1974).

The people of Quinua are subsistence farmers. Only a few people, mostly government workers, have no farms or animal herds. Craft production is a part-time specialization and even most of the merchants rely on their own agricultural production for subsistence. Although everyone sells surplus crops from time to time, only a few townsmen produce cash crops in any regular way. Nonetheless, people ordinarily do not produce all the food that they consume. As will be discussed below, agricultural production is directly related to the mountain ecology, in which each eco-zone specializes in particular foodstuffs. Although Quinuenos try to have fields located in several eco-zones, they are never able to achieve complete self-sufficiency (Fonseca, 1972). Consequently, even within the district there is a lively exchange of foodstuffs between various eco-zones. Moreover, Quinuenos have traditionally obtained goods through trade with other areas of Peru, such as coca and chili peppers from the montaña jungles to the east, and wool and hides from Huancaavelica, a high-altitude region to the west.

The market, held in the central town each Sunday, is an important mechanism for integrating the exchange between different eco-zones. Most exchanges in the market are by barter—women of different ecological zones exchanging their surplus crops. In addition, a man or woman occasionally may journey to a different eco-zone to trade. The person may, for example, bring potatoes and wool from the higher altitudes to exchange for corn grown in lower altitudes. A few men, in the past, also engaged in long-distance trade by mule train with other areas of Peru. Since the increase in truck transportation during the last 30 years, such organized trade by mule train has disappeared. Today, individuals may take their own produce, usually to Ayacucho or Lima, by truck. However, such exchange is still very small.

CLIMATE AND ECOLOGY

Agriculture in Quinua, as elsewhere in the world, is dependent upon temperature and moisture. In Quinua, these variables are determined largely by seasons of the year and altitude.

Quinua has two major seasons, rainy and dry. The rain begins gradually in September or October.

increases in intensity until it reaches its maximum in January and February, then tapers off until it ends around April. The dry season begins in May and lasts until September or October (Rivera, 1967, 1971; Fig. 2). The onset and end of each of the seasons vary from year to year. The amount of rainfall at the beginning of the rainy season differs considerably from one year to the next. It is not until December that the rains consistently come in full force. Distinct dry periods also occur in the middle of the rainy season.

Temperature varies with the seasons (Table 1). The dry season, especially June and July, is the coldest period, with frosts sometimes at night (Rivera, 1967, 1971). The temperature increases gradually in August, so that the rainy season is the warmest

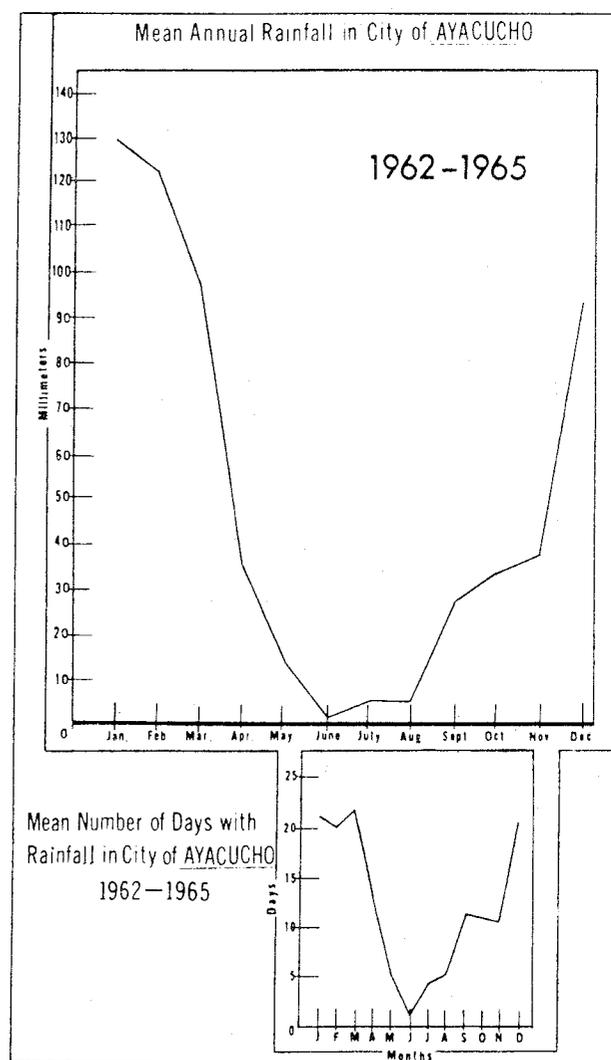


Figure 2. Mean annual rainfall, Ayacucho (data taken from Rivera, 1967).

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TABLE 1. Mean temperature in city of Ayacucho, 1962-66 (data from Rivera, 1967)

Month	Avg. Temperature	Absolute Maximum	Absolute Minimum
	<i>Degrees C</i>		
January	15.6	27.0	7.0
February	15.2	25.4	7.0
March	14.6	25.2	6.2
April	14.9	26.3	3.4
May	14.2	25.6	2.2
June	12.4	25.0	-0.2
July	13.0	25.4	-0.5
August	14.1	26.6	1.4
September	15.0	27.1	4.3
October	16.1	27.8	4.6
November	16.6	29.6	4.7
December	16.0	28.0	5.9

time of year. Although the data in Table 1 are for the city of Ayacucho, the situation is similar in Quinua, except that Quinua is at a higher altitude and is therefore colder. It should be noted, however, that diurnal temperature variation is greater than seasonal variation in temperatures (Troll, 1968). In the Andes, frost occurs at night, while daytime temperatures can be quite high. This is true in Quinua and Ayacucho. Consequently, the crucial figures in Table 1 are the absolute minimum (or night time) temperatures.

Moisture and temperature also are affected by altitude. The higher the altitude, the colder the climate. In the Ayacucho region temperature decreases 0.6° C for every 100 m of altitude (Rivera, 1967, 1971). In addition, altitude affects cloud cover and moisture loss. Higher altitudes are cloudier, a frequent phenomenon in mountain environments such as Peru (Bowman, 1916; Hunt and Hunt, 1974; Peattie, 1936). The farther down the mountain slope, the greater the total amount of sunshine. Both sunshine and high temperature cause greater water loss from soil and plants. The terrain becomes drier as one moves down the mountain slope (Arnold, 1975 and Tosi, 1960).

The effects of altitude on temperature, moisture, and sunshine, allow us to delineate six major vertical ecological zones in Quinua (Arnold, 1975; Mitchell, 1976a, 1976b; and Tables 2 and 3). The zones are differentiated not only on the basis of vegetative characteristics, but also on differential human behavior, especially in agriculture and other extractive activities. My discussion of these zones is based on Arnold's (1975) analysis of Tosi's (1960) classification for Peru. The English terms for these zones are derived from Holdridge (1947), which formed the basis of Tosi's work.

The highest ecological zone is the alpine rain tundra/subalpine wet paramo (4100 + m). This zone, usually characterized as the high puna in Peru, is above the level of agriculture, and is very cold, moist and cloudy. Below it lies the montane prairie (4000-4100 m). This area is characterized by ichu grass (*Stipa ichu*) and other frost-resistant, small size vegetation. It is somewhat warmer than the higher zone. Tubers can be grown there even though the area is above the tree line. Still farther down the mountain slope is the moist forest (3400-4000 m), characterized by a dense underbrush of small trees and shrubs. It is warmer than higher zones, so that frost-resistant, quick-maturing crops are grown in addition to tubers. The lower montane savannah (2850-3400 m) is immediately below the moist forest. The central town is located in the savannah and most of Quinua's population lives here. It is Quinua's major cultivation region, and most of its fields are irrigated. The savannah is divided internally on the basis of irrigation use and altitude into two ecological regions: the upper savannah (3050-3400 m) and lower savannah (2850-3050 m) (Mitchell, 1976a, 1977). Immediately below the savannah lies the lowest environmental zone in Quinua, the lower montane thorn steppe (2500-2850 m). This zone is much warmer, sunnier, and drier than the higher ecological zones. It is covered with cactus and in some areas the vegetative cover may be called a cactus forest. The thorn steppe is unirrigated. It is too dry to be maintained with the very limited irrigation water descending from the savannah. Only plants with low water needs are grown there. In the valley bottom, however, water is obtained from the Rio Chacco. Consequently, this area is irrigated and land use differs here from the upper portion of the thorn steppe. It is for this reason that I treat the valley bottom as a separate environmental zone.

LAND USE

Land use in Quinua is, of course, directly related to the environmental zones. These zones determine broadly whether or not the land is devoted to herding or to cultivation. In a finer perspective, mountain ecology defines such aspects of agriculture as types of crops grown, crop cycles, fallow period, productivity and carrying capacity.

Herding is a specialization of the two highest zones: the alpine rain tundra/sub-alpine wet paramo and the montane prairie. These zones are above the tree line and are characterized by bunch grass and other low, frost-resistant vegetation. Except for tuber cultivation at the lower altitudes in the montane prairie, the growing season is too short for crop cultivation. The people herd pack animals and the Andean cameloids, the llama and alpaca, which are sources of wool and hides. In addition, the people

TABLE 2. Social characteristics of Quinoa ecological zones

Ecological Zone	Elevation		General Characteristics	Land Use	Crop Cycle
	From	To			
Alpine Rain tundra and subalpine wet paramo	4 100 m +		Bunch grass	Grazing	
Montane Prairie	4 000-4 100 m		Bunch grass Frost resistant small size vegetation	Grazing and tuber cultivation	Rainy season cycle
Montane Moist forest	3 400-4 000 m		Dense underbrush of small trees and shrubs	Some herding source of fuel and other wild products Cultivation of tubers and frost resistant, quick maturing crops	Rainy season cycle
Montane Savannah	2 850-3 400 m		Nearly all cultivated	Major cultivation zone Irrigated fields Terracing	Rainy season cycle Dry season cycle
Montane Thorn steppe	2 500-2 850 m		Xerophytic vegetation	Some herding Non-irrigated cultivation of plants with low water needs	Rainy season cycle
Valley bottom	ca. 2 500 m		Xerophytic vegetation	Plentiful water from Rio Chacco Irrigated double cropping Truck farming for City of Ayacucho	Rainy season cycle Dry season cycle
Ecological Zone	Fallow Period		Population Density	Settlement Pattern	Land Tenure
Alpine Rain tundra and subalpine wet paramo			Low	Dispersed	Communal
Montane Prairie	5-6 years		Low	Dispersed	Communal
Montane Moist forest	Long		Low	Dispersed	Communal/Private
Montane Savannah	1/2 year or more		High major population zone	Large nucleated town of Quinoa	Private
Montane Thorn steppe	1/2 year		Low	Small nucleated	Hacienda
Valley bottom	None		Low	Small nucleated	Hacienda

of this zone not only herd their own animals, but also care for the animals (e.g., sheep, horses, cattle) of people who live in the upper savannah. Through this intracommunal symbiosis, the residents of the upper savannah are able to maintain more animals

than they would be able to otherwise without devoting arable land to forage. When the agricultural cycle begins in August, the people of the upper savannah contract with a herder to send their animals to graze in the higher ecological zones. When the harvest

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TABLE 3. Climatic characteristics of Quinoa ecological zones (from Arnold, 1976)

Zone	Evapo-transpiration Potential %	Mean Annual Temp. °C	Annual Precip. mm
Alpine rain tundra/ subalpine wet paramo	less than .50	0-6	500-1000
Montane prairie and moist forest	.50-1.00	6-12	500-1000
Lower montane savannah	1.00-2.00	12-24	500-1000
Lower montane thorn steppe and valley bottom	2.00-4.00	12-24	250-500

begins in May, the animals are returned to the upper savannah where they eat the gleanings and fertilize the fields. They are used in threshing the grain, transporting produce from field to home and plowing the fields. The fertilizer from animal dung is a very important product as well (Winterhalder *et. al.*, 1974).

In addition to the high altitude zones, herding is also significant in the driest zone—the montane thorn steppe. Because of low altitude dryness, combined with a very rocky terrain, much of this zone is uncultivated. Consequently, people who live in the lower savannah frequently herd their animals in the uncultivated regions of this zone. A limiting factor on herding here, however, is the lack of water during the dry season. At such times people must pasture their animals near one of the few permanent sources of water.

Cultivation is found in all zones but the highest, the alpine rain tundra/subalpine wet paramo, where the growing season is too short. However, the type of cropping practiced depends very much on the eco-zone. Because of the effects of altitude on temperature, sunshine and moisture, the people in different zones specialize in different crops. In consequence, the type of crop rotation and length of the fallow period varies from zone to zone. Finally, the presence and function of irrigated farming, the type of crop cycle sown, and crop productivity are also zone related.

Quinoa has two agricultural cycles: a dry season cycle (the *michka*) and a rainy season cycle (*hatun tarpuy*). Different fields are used for each crop cycle. The dry season cycle is restricted to a small proportion of the fields in the savannah and to the valley bottom. In the savannah, dry season crops are planted early, usually at the beginning of August, and depend on irrigation. Sometimes this early planting is used for double-cropping. Two quick-maturing crops are planted in succession. The second crop, planted around November or December, uses natural rainfall. Generally, however, the land lies fallow between

dry season crops. People usually plant a dry season crop not to double crop but to obtain an early harvest when food is scarce. Because of this scarcity, food prices are often very high at this time in the city of Ayacucho, so the dry season crop is often used as a cash crop as well. An additional function of the dry season crop is that it permits two opportunities for agricultural success during the year. It also helps stagger the work load, since the periods of work differ for the dry season and rainy season crop cycles (Mitchell, 1976b). Because there is an inadequate water supply for irrigation for a dry season crop throughout the district, dry season planting is found only in the upper savannah, near the beginning of the irrigation system. In the valley bottom, where irrigation water is plentiful, a dry season planting as part of a regime of double cropping is the rule rather than the exception. Here the dry season planting is always used for double cropping.

The more important, and more widespread, agricultural cycle is the rainy season planting. It produces most of the district's food-stuffs and is present in all the ecological zones that are cultivated. The time of planting, however, differs according to ecological zone (Mitchell, 1976b).

In the montane prairie and moist forest, the two highest zones with agriculture, the rainy season crops are planted in November or December with the onset of the rains. In these zones a limited repertoire of frost-resistant and quick-maturing crops is grown without irrigation (Mitchell, 1976a).

In the lower montane savannah the sequence for planting the rainy season crops depends upon altitude. In the upper portion of the savannah the crops are usually planted over a period of several months. Planting starts in the highest altitudes of the savannah in September and the sequence of planting descends, field by field, until the final fields are planted with the onset of the rains in December. This order is determined by the physical requirements of agriculture in this zone. Farming in the upper portions of the savannah is made possible by irrigation. Irrigated farming is a widespread and ancient Andean method that permits the cultivation of crops—especially maize—at higher altitudes than would be possible with rainfall alone (Mitchell, 1976a, 1977; Murra, 1960). The physical requirements of such agriculture (variables of frost, maturation time of crops, duration of rainy season and amount of irrigation water) demand that higher altitudes be cultivated first (Mitchell, 1976a, 1977).

In the lower montane thorn steppe the time for planting the rainy season cycle is in December with the onset of the rains. In the valley bottom portion of the thorn steppe, however, the rainy season crops are planted whenever the dry season crops are harvested. This is the only area of Quinoa in which

there is sufficient irrigation water to permit planting without strict considerations of timing.

The ecological zones not only determine the crop cycle and the time of planting, but also the types of crops grown. Each altitude zone specializes in particular crops. Moreover, the length of fallow period and productivity are also zone related. As a general rule, the higher the altitude the fewer the variety of crops grown, the longer the fallow period, and the less the productivity of the land. The lower productivity of higher altitudes is also a result of the ratio of evapotranspiration to rainfall (Tosi and Voertman, 1964).

In climatic situations in which more moisture is added through precipitation than is lost through evapotranspiration, soluble nutrients are lost from the soil by leaching. This is the case in Quinoa in the higher altitudes where the evapotranspiration potential is low (Tosi, 1960; Table 3). In the lower altitudes, however, the amount of evapotranspiration is greater than the amount of precipitation, so that the soluble soil nutrients are not lost as readily from the soil (Tosi, 1960; Tosi and Voertman, 1964). In Quinoa, the only areas with a favorable evapotranspiration potential are the savannah, thorn steppe and valley bottom (Table 3).

The highest zone in which crops are grown is the montane prairie. Potatoes (*Solanum* spp.) grow at the highest altitudes and other Andean tubers, maswa (*Tropaeolum tuberosum*), oca (*Oxalis tuberosa*), and olluku (*Ullucus tuberosus*), at somewhat lower altitudes. The fallow period in the zone, especially in potato cultivation, is five to six years. The factors responsible for this long fallow are the limited crop repertoire with which to practice crop rotation and the low evapotranspiration potential, as well as the type of soil and the requirements of the particular crops grown.

A greater variety of crops is grown in the moist forest. In addition to the Andean tubers, this zone is also devoted to other short-growth, frost resistant crops such as wheat (*Triticum durum* and *T. sativum*), haba or broad beans (*Vicia faba*), peas (*Pisum sativum*) and a high-altitude variety of quinoa (*Chenopodium quinoa*).

Much of this zone is uncultivated and the fallow period is several years. Moreover, clouds hover around this zone for longer periods than in other zones. Consequently, much of the zone consists of wild trees, shrubs, and other vegetation. These trees and shrubs are used as sources of firewood and basket-making materials. The wild vegetation is also an important source of culinary and medicinal herbs. The presence of a zone in which fuel is produced helps reduce the reliance on animal dung for fire, and permits the dung to be used for fertilizer, an important Andean resource (Winterhalder *et al.*, 1974). In addition, the presence of a moist forest

on the steep slopes above the savannah limits soil erosion and landslides. As the moist forest is located directly above the major population and cultivation zone of Quinoa, this is an important, although culturally unrecognized, function of this zone.

The montane savannah is Quinoa's major crop production zone, and the zone with the largest percentage of land under cultivation. Irrigation farming (Mitchell, 1976a, 1977) and the cultivation of such staples as maize (*Zea mays*), beans (*Phaseolus vulgaris*), and most squash (*Cucurbita* spp.) is restricted to this area and the valley bottom. Other crops, such as some varieties of potatoes, wheat, barley (*Hordeum* spp.), oats (*Avena sativa*), low-altitude quinoa, and peas are also grown here. The great variety of crops planted in the savannah enables Quinuanos to utilize complex systems of crop rotation and crop interplanting to maintain soil fertility in this zone. Because of such rotation, as well as because of the higher evapotranspiration potential, there is no real fallow period in the savannah. All fields are cropped annually in this zone. In fields devoted to the rainy season planting, the fallow may last only four to six months. In double-cropped fields there is no fallow at all.

The montane thorn steppe, which is farther down the mountain slope, is not as intensively cultivated as the montane savannah. This zone is drier than the upper regions of Quinoa. It receives less rainfall, and the evapotranspiration potential is also higher (Table 3). Except for the valley bottom, this zone is not irrigated. It is too dry to be maintained with water from the present irrigation system, so that only plants with low water needs, such as wheat, qewinka (a type of squash, *Cucurbita* sp.), peas, and chick peas (*Cicer arietinum*) are grown. The fallow period is about six months. There are many areas in this zone that are too rocky to be cultivated.

Irrigation water is plentiful in the valley bottom. This makes it possible to plant both the rainy season and dry season crop cycles. Because of the abundance of water and the warm climate, farming in the valley bottom is continuous throughout the year, with one crop planted after another. This region specializes in the production of green vegetables for sale in the city of Ayacucho.

An important aspect of agricultural adaptation to the mountain ecology of Quinoa relates to crop specialization. Not only are the species of crops grown different depending upon altitude, but the varieties of the same species are often different as well. For example, three varieties of the Andean grain known as quinoa (*Chenopodium quinoa*) are grown. Each of them is specialized for different altitude zones. Quinoa morocho is a low-altitude variety grown throughout the savannah. Ruyaq quinoa is a variety grown in the upper altitudes of the savannah and the moist forest. Finally, quinoa

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morada is sown only in the moist forest. Such variety specialization is true for maize, wheat, potatoes, oats, oca, olluku, maswa, barley, peas, habas, squash, cabbage (*Brassica oleracea*), beans—in fact, most of the cultigens found in the district.

SETTLEMENT AND POPULATION

Productivity and carrying capacity are related to the land use found in each eco-zone. Consequently, settlement patterns and population density also reflect adaptation to the mountain eco-system.

In the moist forest and above, population is sparse and settlements are small. This low population density is a function of the exploitative patterns throughout this region: herding combined with long fallow farming of a restricted range of crops. There is little possibility for intensification here, and the production of calories is limited.

The montane savannah, which is the major cultivation zone, is the region of densest population. Most of the nucleated settlements are located here. The irrigation system, itself an adaptation to the mountain ecology, provides sufficient water for domestic use throughout this zone (Mitchell, 1976a, 1977). In addition, people locate themselves near their primary agricultural fields.

Large settlements are located only in the savannah and only in those areas which permit multiple access to two or more ecological zones. These settlements are located at the border of the montane savannah with another ecological zone. The central town of Quinua and the hamlet centers of Moya and Wiripaqcha are located in the upper montane savannah near the border of the moist forest. This permits ready exploitation of these two zones. In addition, the central town of Quinua is at the physical center of the district, hence it is strategically located as an interconnecting point between all zones, and permits people who live near the town to exploit a range of environments. At the market held in Quinua each Sunday, goods from the various environmental zones are exchanged.

Nucleated settlements (viz Llamawillka, Murunkancha, Chiwampampa) are also located in the lower savannah where it borders the montane thorn steppe. People in these settlements live near their major fields, as well as near adequate supplies of domestic water, and utilize the thorn steppe for cultivation of subsidiary crops and to herd their animals. For this reason, people from the lower savannah do not contract to have their animals pastured in the high-altitude ecological zones.

Except for the valley bottom niche, few people live in the montane thorn steppe. Because of the greater evapotranspiration and reduced rainfall there is insufficient water for habitation during the dry season. The few sparsely populated settlements are located near the few permanent supplies of water.

The archeological site of Huari, located in this zone, has no permanent habitation at the present time. In the past, Huari probably would have required an aqueduct to provide domestic water for the city (Mitchell, 1976a, 1977). The montane thorn steppe is primarily cultivated at the present time by people who live in adjoining zones.

Although the valley bottom is technically located in the thorn steppe, the abundant and reliable supply of river water permits habitation and, by means of irrigation, extensive cultivation. This zone is more densely populated than the rest of the thorn steppe and contains, as part of the district, two small nucleated hamlets (Chacco and Muyurina). In addition to cultivating the valley bottom, the people from this zone also exploit the upper portions of the thorn steppe.

LAND TENURE

Land tenure also is related to the exigencies of adaptation to the mountain eco-system. There are three systems of land tenure in Quinua: communal, private, and hacienda. Each of these is found in different eco-zones. We will exclude haciendas from consideration because they were imposed through force by the national political system. For private and communal tenure, the most important determining factor is the length of fallow, an observation which has also been made independently for New Guinea (Brown and Podolefsky, 1976). Short fallow cultivation entails major capital investments such as irrigation systems, fences to keep out animals, terraces, and the planting of important perennial plants such as fruit trees, cactus and maguey. Short fallow fields are also more productive. Consequently, these fields are privately owned. Long fallow fields, on the other hand, do not entail many capital expenditures and have large areas of uncultivated terrain, which are used by the community for grazing land, wild herbs, and fuel. In consequence, eco-zones in which long fallow cultivation is practiced are communally owned.

In the moist forest zone and higher, land tenure is communal. The land belongs to the formally recognized rural community (*comunidad campesina*) and technically is distributed by the President of the community. In actual practice, however, this land is inherited by children. However, if land is left idle, ownership reverts to the community which can then redistribute it. Unused land is distributed by the community to those who have passed all their communal civil and religious obligations (*cargos*). A person cannot sell his use rights in communal land.

The real meaning of communal tenure in the higher altitude zones is not that everyone can cultivate here, but that the entire community has the right to utilize

the wild products produced by the long fallow period. People from the montane savannah can thus exploit the terrain for fuel, herbs, and other materials, even though they do not have any cultivation rights. The person with cultivation rights cannot prohibit this use of the land.

In the montane savannah and montane thorn steppe, there is a short fallow and thus fewer wild products. Consequently, most fields in these zones are under constant cultivation, and tenure is private, although in a few areas haciendas own the land. The few important wild plants, such as cactus, belong to the person on whose field they are located. Only the owner of the field has the right to use these plants. Nonetheless, some notion of communal land use is found in these zones. The owner of a field has the first right to graze animals on his field after the harvest. However, once he has done so, grazing rights become communal.

Land tenure is related to ecological zones in another way. The optimal strategy for any family is to have fields in more than one ecological zone. In this way, it achieves maximum diversity in the crops it produces. Such a strategy also minimizes the effects of crop failure which seldom affects all zones simultaneously. In addition, the strategy of different fields in different eco-zones allows a person to sow his fields in succession, thus staggering the workload. Few people, however, are actually able to achieve this optimal tenure strategy.

SOCIAL ORGANIZATION

Other dimensions of social organization related to the vertical ecology are the system of social stratification and barrio organization. A common phenomenon throughout Peru is the belief that Indians are found only in high altitudes. In Quinua, the people of the savannah and lower elevations tend to regard everyone from the high altitudes as a *chutu* or Indian, which is a mark of disrespect (c.f. Mitchell 1974). Nonetheless, most people speak Quechua and are racially similar, regardless of altitude. Consequently, the different perceptions are at least partially linked to differential productivity. Indians are those who exploit terrains of low productivity. This low status of *puna* inhabitants may go back to pre-Columbian times as well (Garcilaso de la Vega, 1966).

The *barrio* division of Quinua is another aspect of social organization related to the vertical ecology. Since some aspects of the fiesta system and political organization are organized around barrio lines, these social features are at least indirectly related to the mountain ecology as well.

Quinua is organized into two barrios: Lurin Sayoc and Hanan Sayoc. This division is very important in the political, religious and ecological organization of the community. Each barrio has its own irrigation

system. They also alternate in giving annual religious fiestas. In the recent past each barrio also had a separate rural political organization (*varayoc*). These barrios are not moieties, a term which should be restricted to dual kinship divisions (Murdock, 1949). Membership and participation in the barrio is determined by residence; it is not based on rules of descent. Moreover, the barrios are not upper and lower altitudinal divisions as is frequently assumed to be the case in other parts of the Andes. Barrio divisions are very ancient in Peru, going back to Inca and probably pre-Inca times (Baudin, 1961; Castro Pozo, 1946; Garcilaso de la Vega, 1966; Kirchoff, 1949; Means, 1931; Montesinos, 1920; Rowe, 1946). They are found widely in the highlands today, although the division is sometimes into three or four rather than two units (Adams, 1959; Arguedas, 1964; Isbell, 1972; Mishkin, 1946; Snyder, 1960; Stein, 1961; Tschopik, 1946 and 1951).

Quinua's barrio divisions are based on the hydrology of the mountain slope on which the community is located (Mitchell, 1976a, 1977). The central area of Quinua lies on a mountain slope with two major drainage systems (Fig. 3), one draining into Huamangura ravine, and the other into Hatun Wayqu (big ravine). The dual division of Quinua into Lurin Sayoc barrio and Hanan Sayoc barrio reflects this hydrological situation, and the ecological and cultural boundaries coincide. The hydrological basis for the barrio division is not verbally recognized by the community and it may be for this reason that it has not been reported elsewhere in Peru, although the literature suggests that the pattern occurs elsewhere (Mitchell, 1976a, 1977).

The major productive variable in the hydrological basis for barrio organization is irrigation technology. The irrigation systems of Quinua exploit the drainage patterns on the mountain slope. Consequently, there are two separate irrigation systems, one for the barrio of Lurin Sayoc and another for Hanan Sayoc. Since irrigation is itself an adaptation to the vertical ecology, in that it raises the upper limit of maize cultivation (Mitchell, 1976a, Murra, 1960), barrio organization is indirectly related to the mountain ecology as well.

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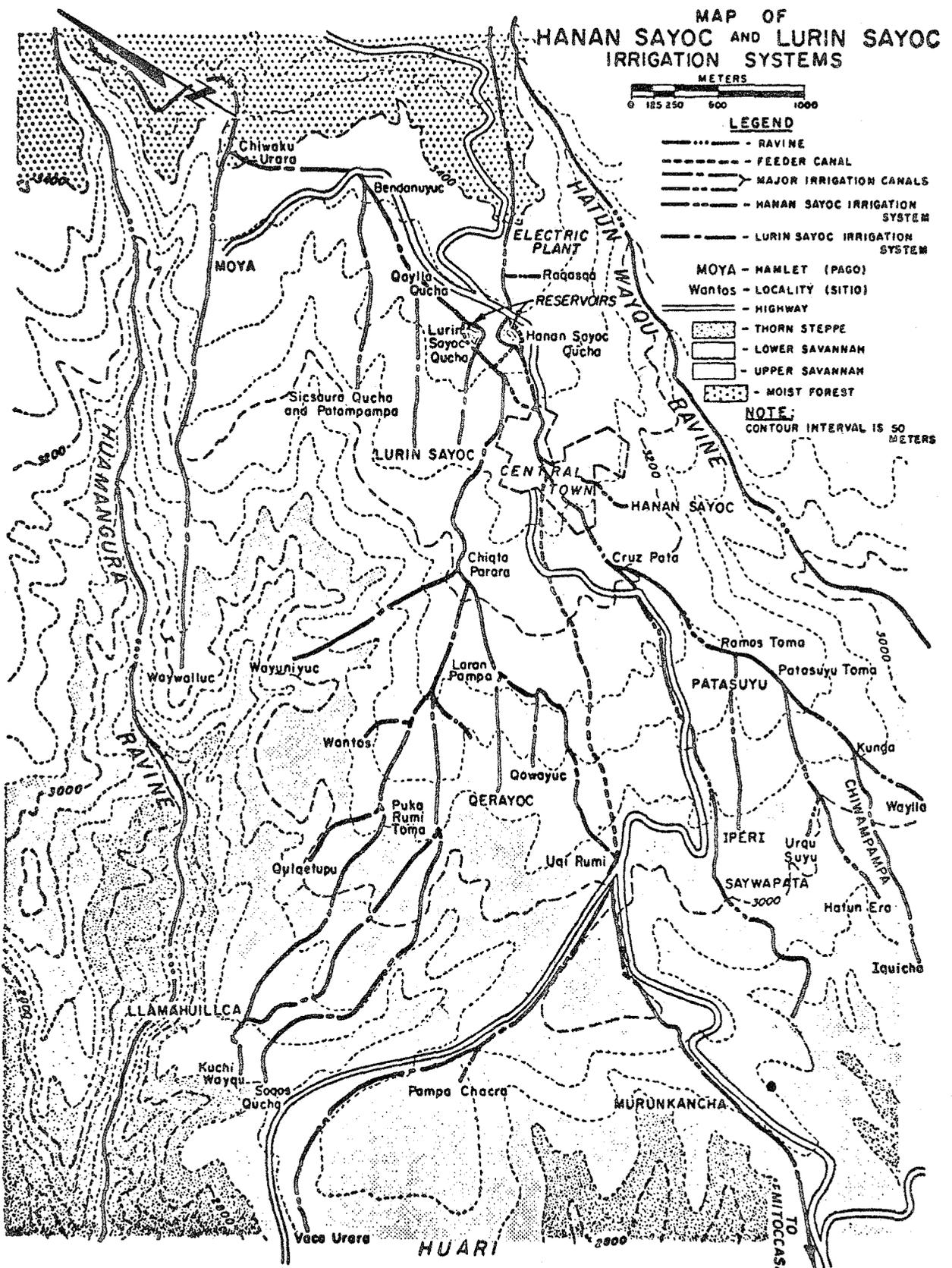


Figure 3. Hanan Sayoc and Lurin Sayoc irrigation systems.

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