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# ARCHAEOLOGY AND DEVELOPMENT: A TITICACA BASIN EXAMPLE.

por

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## RESUMEN

*El presente trabajo se refiere a las potenciales contribuciones de la arqueología a los estudios de los pueblos que habitan el área del Tercer Mundo, cuyo desarrollo está siendo planificado por agencias gubernamentales. Esta planificación, sin embargo, a menudo cuenta con escasos datos de largo plazo susceptibles de utilizarse en planificación. El trabajo arqueológico puede servir a este proceso proveyendo información de largo aliento en lo que se refiere a las relaciones hombre-medio. El énfasis del artículo está puesto en la relevancia de la información arqueológica para la planificación del desarrollo en la Amazonía y en el Titicaca.*

This paper concerns the potential contribution of archaeology to the study of people in areas being "developed" by government agencies of industrialized and third world nations, under the guidance of planners. Most planning, however, often occurs with little long-term data available that can serve as a guide to planning. Archaeological work could inform the planning process by providing information on human-environmental relations over a long span of time. In this presentation, I focus on the relevance of archaeological data to the planning of development in Amazonia and the Lake Titicaca basin.

I will first provide evidence for climate and food procurement changes in the northern altiplano, specifically Lake Titicaca. These changes are then related to contemporary climate changes over much of northern South America. The adaptations of altiplano populations affected by the climate change are then examined.

Finally, I argue that similar broad environmental changes may be occurring today. The potential effects of the current climate changes on human populations of the altiplano are discussed, and these potentialities are viewed as having important lessons for development planners.

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The Titicaca basin lies in the northern portion of the altiplano of Perú and Bolivia (Fig 1). Like other altiplano areas, the rainfall in the basin is quite seasonal (Unzueta 1975; O.N.E.R.N. 1965).

The agricultural and pasturage productivity of the basin is regulated by a combination of rainfall and temperature - related factors. In studies carried out during the last 20 years, it has been found that in the years in which temperature and rainfall are irregularly distributed (i.e., uneven) during the rainy season, there is a marked reduction in agricultural yields, even though the averages may be optimal (O.N.E.R.N. 1965: vol. 1, p. 45). Improved production occurs when rainfall and temperature are more evenly distributed throughout the rainy season. This rule applies to pasturage yields as well.

The lake environment is characterized by an extremely rich variety of flora and fauna. This variety has provided much of the stability that can be observed in the archaeological record of the last 4000 years. In earlier work (Kent 1982a, 1982b, and 1983), I examined the available cultural, floral, and faunal evidence from the Titicaca basin and suggested that, in general, broad terms, the pattern of resource utilization has not undergone drastic shifts over the last 3500 years.

Human adaptation to the lake involved a combination of the following: rainfall agriculture; hunting of birds; fishing; collection of plants and even algae from the surface of the lake; pasturing of domesticated camelids; hunting of wild ungulates (guanaco and vicuna in the camelid family and deer in the cervid family); raising of guinea pig

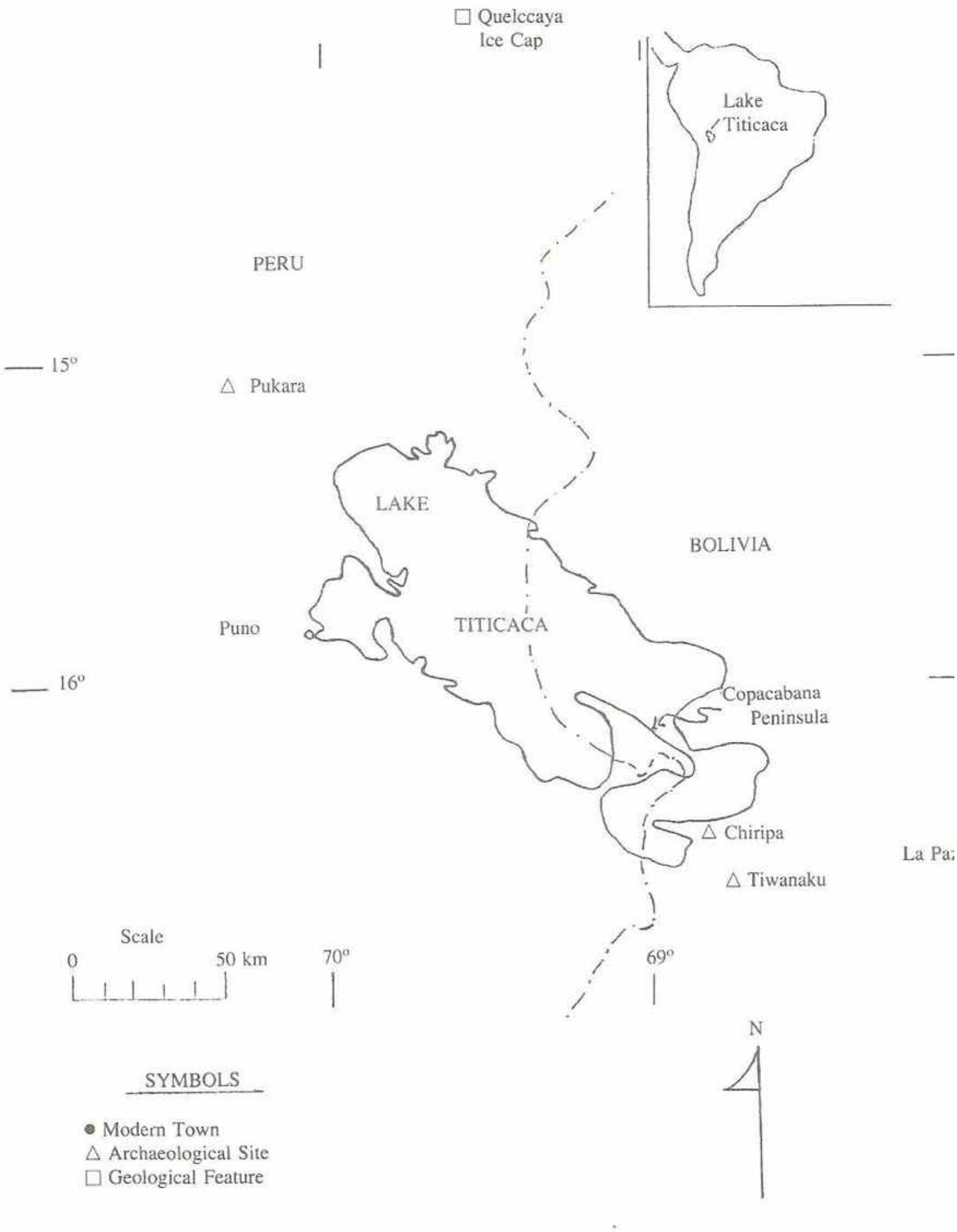


**Figure 1.** Lake Titicaca with Localities Mentioned in Text (After Kidder 1943:4).

and chinchilla; irrigation farming using communally maintained canals, raised fields, and terraces; and, the use of plant and animal products from different local microenvironments in a variety of healing and magical contexts (see works cited above).

These forms of utilization have been supplemented by economic ties both within and outside the altiplano. These ties have occurred in the form of: direct exchange through a series of communities, somewhat analogous to the Kula ring; local, regional, and interregional periodic markets; and, entrepreneur-type mercantile trade by full-time specialists. These patterns appear to have been in effect for al least the last 2000 years (e.g., see Browman 1981).

In spite of the long-term, broad-scale stability of the human adaptations to the Lake Titicaca zone, archaeological data indicate that during a certain critical period there have been significant shifts in emphasis on the various components of this economic pattern. These shifts correlate temporally with what I believe to have been a significant climatic change in the Titicaca basin. In addition to the climate change and correlated economic changes, there were also changes in other aspects of Lake Titicaca cultural patterns that are too numerous to be attributed to chance.

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Detailed subsistence analyses employing archaeological flotation recovery techniques have only been carried out at a few sites in the northern altiplano and only at one site in the Titicaca basin: Chiripa, Bolivia. Conclusions based on the subsistence analysis at Chiripa are, therefore, somewhat unique and need to be confirmed by analyses at other contemporary sites in the same area.

The results of the Chiripa floral and faunal analyses have been reported elsewhere by Browman, Erickson, Horn, and myself (Browman 1980, 1981; Erickson 1976; Erickson and Horn n.d.; Kent 1982a, 1982b, 1983). A few of the results are relevant to the present theme.

First, there is an increase in the relative frequency of birds (mostly lake-edge fowl such as coots, rails, and greves) over time. This increase is most visible in comparing levels from before Chiripa Phase III (starting at 2600 B.P.) with those that follow, and the difference is statistically significant (Chi-square: $p < 0.001$). A shift toward lake-edge water fowl suggested increased use of lacustrine resources.

From the lake edge, another shift is apparent at about 2600 B.P. Prior to that time, Juncus (genus) predominates. This is a plant that requires moist conditions (Tapia N. 1971: 96). After the start of Phase III, the totora plant (genus Scirpus) becomes the dominant aquatic zone plant. Thus, there is a shift away from a moisture-dependent plant to a lake-edge plant. This seems to me to suggest the possibility that conditions favorable to Juncus (genus) had changed. Nevertheless, there are other ways to explain the observed shift in relative abundance of these plants so that this evidence cannot be considered in isolation from the other data presented.

A third shift at this same time takes place in plants of the grassland microenvironment. Festuca (genus) becomes less common relative to Stipa (genus). Without species-level identifications, it is impossible to say what such a change might imply with respect to environment or economic changes. Furthermore, the fact that these plants produce a great number of seeds as well as a great deal of variation in the number of seeds, makes quantitative comparison of flotation samples somewhat tenuous (Erickson, personal communication). Therefore, I merely note that the change is observed without attaching any undue significance to it.

Although these shifts by themselves are not totally conclusive pieces of evidence for any climatic or economic changes, taken together, ther are hints of increasing aridity (lessening Juncus), and greater use of lake and lake-edge resources (increasing water fowl and increasing Scirpus). Fortunately, there are some recently discovered and quite independently derived climatic data which also suggest increasing aridity at this time. Part of these data come from glaciological studies of the Quelccaya ice cap in southern Peru.

The Quelccaya ice cap is located on the northern altiplano in the Nudo de Vilcanota (see Fig. 1). Studies on various features of the cap over the last two decades have indicated that advances and retreats in the extent of the ice cap can be correlated with and possibly attributed to changes in precipitation (Thompson et al. 1979: 1243; Mercer and Palacios 1977; Mercer, personal communication). In such circumstances, a drier climate would contribute less moisture to the maintenance of an extensive ice cap, and shrinkage would occur. Increasing precipitation, on the other hand, would lead to growth of the cap.

Mercer and Palacios (1977) have obtained radiometric dates on the moraines associated with the advances and retreats of this cap. These dates indicate that it became smaller than its present extent during the period 2700-1600 B.P. (Mercer and Palacios 1977: 604) (I should note that although warming temperatures have also been suggested as a mechanism for the shrinkage of mountain glaciers, the recent shrinkage of glaciers in southern Bolivia without an accompanying warming trend suggests to Mercer (personal communication) that warming was not the primary mechanism responsible for the shrinkage of the Quelccaya ice cap.). Mercer suggests (personal communication) that the reduction in the size of the ice cap was due to reduced precipitation during the period 2700-1600 B.P.

Additional evidence for aridity during this period comes from the study of montana paleosoils and erosion patterns east of Santa Cruz, Bolivia. There, Michel Servant and colleagues have determined that there have been two major periods of degradation and disappearance of the Amazon forest during the Holocene: one between 7,000-5,000 B.P., and one between 3,400-1,400 B.P. (Servant et al. 1981: 1297). Both episodes were due to the reduction in ground cover and the consequent increased runoff of soil from the eastern Andean slopes. The mechanism has been described for this area by Gentry and Lopez-Parodi (1980) and Caufield (1983). The latter episode of forest degradation corresponds quite well with the dates of the shrinkage of the Quelccaya ice cap. It thus seems reasonable to argue for aridity on a very broad scale over this portion of the continent during the time indicated. This would incorporate the eastern slopes of the Andes as well as the Titicaca basin.

These changes may, in fact, correlate with those proposed by Meggers for Amazonia as a whole (Meggers 1974, 1975. See also Sanchez and Kutzbach 1974; Vanzolini 1973. For rebuttal see Whitten 1979, but for reply see Meggers 1979). She has argued for repeated and severe climatic oscillations in Amazonia, the most recent dating to sometime between 3500-2000 B.P. During this time, she argues, aridity was greater than at present, and it created conditions leading to degradation of the Amazonian forest and the creation of widely separated stands of trees that would act as refugia for forest-adapted species. Independent studies on a variety of organisms suggest that speciation events were more frequent during such degradation episodes, due largely to reproductive isolation. Included are a variety of reptiles, insects, and birds (Haffer 1969; Vanzolini 1973).

This last arid interval overlaps with the start of the arid period I am proposing for the altiplano and Bolivian montana. Furthermore, there are marked changes in sociopolitical and economic organization of the populations of the Lake Titicaca basin indicated in the archaeological record for this period.

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By 3000 B.P., dispersed communities of farmer/pastoralists occupied the northern, western, and southern portions of the basin, extending even down into the central Bolivian altiplano. Stylistic similarities in ceramics have been noted for a number of sites dating to the period 3000-2850 B.P., including Qaluyu, Pikicallepata, Pizacoma, Sokotina, and Wankarani (Mohr-Chavez 1977; Browman 1980). Sites in the Titicaca basin were little differentiable archaeologically, a situation that stands in sharp contrast to that of the following period.

Between 2850-2600 B.P., a technological boundary developed which allows the archaeological separation of the northern and southern portions of the Titicaca basin. This boundary was located approximately at the Copacabana Peninsula (Fig. 1). The use of fiber-tempering in ceramics of the southern half of the basin is the diagnostic technological distinction (Browman 1981: 413; Hyslop 1976; Mujica, n.d.).

The boundary between the northern and southern Titicaca basin is progressively accentuated after 2600 B.P. The political entity at Pukara (Fig. 1) dominated the northern half of the basin, while at first Chiripa, and later Tiwanaku, dominated the southern half (Browman 1981: 413).

At this same time, there is already evidence for increasing interaction between the highlands and the selva, primarily in the form of non-subsistence items such as copper and obsidian. This occurs not only in the Titicaca area (Browman 1981: 413), but also in the valley of Cuzco to the north. There, in Marcavalle Phase D (with dates centering at about 2700 B.P.), Mohr-Chavez reports excavating a drilled peccary tooth a clear indication of interaction with the jungle (Mohr-Chavez 1977: 32). This is most interesting in that other Marcavalle remains do not indicate much in the way of external interactions until this time. Furthermore, in the same phase, a small carved bone in the form of a bird has been tentatively identified by Elizabeth Wing as having the shape of a parrot, an animal also native to the selva (Mohr- Chavez 1977: 32).

Thus, in addition to the increase in interaction between highlanders of the Lake Titicaca basin and occupants of the selva, there is contemporary evidence for some contraction of spheres of interaction (as measured by the technologically similar ceramics in each half of the basin) within the basin itself: one sphere forming in the north of the basin, the other in the south.

One way to reconcile expanding trans-Andean interactions with contracting intra-altiplano interactions is to view this as a period of political strengthening and consolidation within both the northern and southern altiplano zones.

There is some evidence for such political consolidation at this time from the site of Chiripa. During excavations in 1975, we discovered that underneath the floor of a Middle Horizon (A.D. 600-1000), Tiwanaku period temple, there were traces of an earlier Chiripa period temple dating to just after 2600 B.P. Built of massive sandstone and limestone blocks, some of which were undoubtedly trans- ported from at least 20 km. away, this temple is the earliest evidence of monumental construction known from the southern portion of the lake.

Both the construction of such a large-scale architectural feature as this temple and the transport of large blocks of building materials over considerable distances bespeak concerted communal labor, perhaps under the control of an emerging political elite, at this time. No evidence for organized labor projects engaged in non-subsistence activities exists at Chiripa prior to 2600 B.P.

This phenomenon was not limited to the sphere of influence being consolidated on the southern side of the lake, for similar changes were occurring in the Pukara area, north of Puno, Peru. There, large scale architecture is known earliest from Cusipata times at Pukara, i.e., sometime after 2800 B.P., but before 2200 B.P. (Patterson 1968;

Mujica, n.d.: 20; Mohr-Chavez 1977: 1028). So, both on the northern and southern sides of the lake, political consolidation accompanied by increased control over communal labor devoted to non-subsistence projects occur during the middle of our proposed period of aridity.

The development of expanded political control during extended arid periods is well documented. For example, during drought on the Great Plains between 1933 and 1939, the amount of grazing land needed per head of cattle rose from a former figure of 4. 0-4. 8 ha/animal to a figure of 20-30 ha/animal. This was due to a drought-induced decline in pasturage productivity. As a result of the greater amount of land per head that was needed, ranchers exerted pressure on politicians to open up additional lands for grazing (Albertson et al. 1957; Coupland 1959). When the effects of drought are combined with the pressures exerted by large herds on grazing areas, the effects are logarithmically more severe. If, in the altiplano, highland/jungle interaction was conducted by llama caravan, as was almost surely the case (Browman 1980), then the increase in interaction might well have been accompanied by growth in herd sizes being grazed in the Titicaca basin. With the onset of increased aridity, with accompanying declining productivity of grazing lands, a need for political consolidation and increasing control over grazing lands or grazing rights might have arisen.

By the middle of the arid period, the northern and southern portions of the Titicaca basin were well divided politically, socially, and economically. In the north, Pukara becomes increasingly urbanized, while in the south Tiwanaku is starting to achieve its own preeminence. With the onset of moister conditions about 2000 B.P., Tiwanaku had assumed control of the long-distance llama caravan trade. This trade connected the jungle, highlands, and Pacific coast in a network that provided not only status-validating or luxury goods (copper, obsidian) as before, but now included new items of a more basic nature such as produce, fish, textiles, pottery, hallucinogens, and other medicinal plants (Browman 1980: 116; 1981).

The reason such trade controls were necessary may be related to the fact that there seems to be a proliferation of sites around the lake during this period. Settlement pattern data collected by Hyslop (1976), Mujica (n.d.), and by us on the Taraco Peninsula of Bolivia (the peninsula on which Chiripa lies) all indicate an explosion in numbers of sites during the first few centuries A.D. By the third century A.D., Tiwanaku had emerged as a true urban center controlling commerce in southern Peru, most of Bolivia, northern Chile, and northwestern Argentina (Browman, 1981: 415). It seems reasonable to suppose that the lake and the nearby pastoral resources which together had supported the polities of Pukara and Chiripa for at least several hundred years, were no longer sufficient to provide sufficient food resources for the ever-growing population. Centralized control of the long-distance trading network would have helped to ensure the continued flow of commodities during a time of increasing demographic strain on local resources.

In sum, after 2800 B.P. in the Titicaca basin, rainfall became less evenly distributed through the rainy season, and consequently agricultural and pasturage productivity began to decline. At the same time, or shortly thereafter, there is increasing use of lacustrine resources, and changes occur in the use of pasture grasslands. Increasing degrees of communal labor efforts and perhaps the rise of a political/religious elite follow, probably as a means of dealing with the social stresses occasioned by strains on the productive system. At Chiripa, houses are contructed with double walls with niches in them that served storage functions (Kidder 1956). Nutritional stresses are also suggested by archaeological traces of mineral-rich clays that appear for the first time after 2600 B.P. (Browman

1981). Browman points out (1981: 412) that the consumption of clays for their Ca, Mg, Fe, Na, and K content (geophagy) is important today among altiplano populations, and that such clays were commodities transported frequently by llama caravans (He cites Flores Ochoa 1977).

So people of the altiplano, under conditions of strain on the productive systems, turn to the lake and to long-distance exchange to ever-increasing degrees. It is probable that raised fields, which were constructed prior to this time (Erickson, personal communication), were used to increase the productive capacity for the burgeoning population. The supervision of intensive agriculture and long-distance exchange networks are two commonly-cited mechanisms for continued development of socio-economicallly complex societies. The formation of the Tiwanaku state was, I believe, a combination of population growth during a moister period than that which preceeded it, and the existence of already complex social system which had arisen to cope with an extended period of aridity and uneven rainfall. Certainly other social, political, and economic factors were involved in these developments. To haul out climate change at a period of archaeologically detectable cultural changes is not a valid technique for deriving satisfactory explanations of socio-cultural change. On the other hand, ignoring the potential effects that climatic change might have on cultural changes is also a mistake. In this case, I am suggesting that increasing aridity was a very significant factor that may have triggered, but certainly continued to reinforce the development of social complexity in the Titicaca basin.

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I have argued that there had been an increase in consolidation and dependence on external (vs. local) means of production in the Titicaca basin which was occasioned, in part, by an extended period of aridity. I have also suggested that the decrease in precipitation was accompanied by a general, and fairly widespread, degradation of the Amazon forest. There is a direct relationship between Amazonian degradation and precipitation in the altiplano. Moisture-bearing air currents sweep across the South American continent from east to west. As these trades cross Amazonian and meet the eastern slopes of the Andes they are cooled and most of their moisture is released as precipitation on the eastern slopes or adjacent highlands (Johnson 1976: 154). A rain-shadow effect is created on the western slopes of the Andes.

However, with degradation of the Amazonian rain forest, the currents sweeping across the landscape are heated even more by the increased solar reflectance of the land mass (i.e., the vegetation cover that would normally trap solar energy is greatly reduced). This forces the moisture-laden air masses much higher, increases their moisture-holding potential, and these masses thus travel much farther to the west than they would have given normal canopy cover in the Amazon area. Rain thus falls on the western slopes of the Andes, while it bypasses mountain areas such as the altiplano. In addition, the reduction in forest cover lowers the amount of transpired moisture available for rainfall occurrence both on the eastern slopes and highlands as well as within the Amazon itself. Some investigators feel that this process is one that continues to reinforce itself, and one that may eventually bring about the total desertification of the Amazon basin (Gentry and Lopez-Parodi 1980; Goodland and Irwin 1975).

Increasing demands for development of the Amazon forest, including settlement, dam construction, and oil exploration by Brazil, Paraguay, Peru, and Bolivia have recently (within the last two decades) begun to have a significant degradation effect on the forest cover within the Amazonian drainage (Caufield 1983; Gentry and Lopez-Parodi 1980; Hecht 1981).

The effects are already being noticed both on the altiplano and on the western Andean slopes. In 1976-1977, farmers of the Puno area of Lake Titicaca were complaining of an extended drought having begun (Tom Lennon, an anthropologist then doing his dissertation research on ridged-field technology, personal communication), and it continued during the 1977-1978 growing season (Of course, this was prior to the devastating drought effects of the recent El Nino event which involved world-wide climatic shifts).

On the Plain of Nazca, situated on the western Andean slopes, is the site of the famous lines and human-made intaglios or geoglyphs. Maria Reiche, a thirty-year resident and investigator of the origins and meaning of the ground markings, observed that the Nazca Plain was receiving rain for the first time in her memory (Reiche, personal communication). She expressed serious concerns over the destruction of the Amazonian rain forest and the consequent occurrence of rainfall on the area of the ground drawings. The rain was beginning simply to wash these ground drawings away.

Should the present human-induced degradation of the Amazon continue –and the funds for the continued construction of dams, pipelines, and settlements are committed well into the future (Caufield 1983: 65-66)– then it would be useful to consider the potential effects of such a process on the inhabitants of the Titicaca basin.

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The stability in resource utilization in the altiplano mentioned above and the increases in production that maintained this productive system in the face of shifting climates were the results of a long period of accumulating knowledge on the variations in resource availability and scheduling in response to such variations. Archaeological ev ago, and that it was one that was sufficiently succesful to maintain pastoralist/farmers in the altiplano at fairly high levels of population prior to the Spanish conquest (Murra 1975).

One of the factors that had allowed political/economic consolidation and increased production after 2600 B.P. (our arid period) was the use of labor-intensive means of production combined with long-distance exchange from altiplano to jungle and Pacific coast. These means of production and the long-distance trade relationships are no longer operable. One problem that is most severe is the lack of a large labor pool in the altiplano, sufficient for terraces, raised fields, qochas, hoyas, etc. Most of the labor has migrated either to find wage positions in La Paz conditions by intesifying production on the local level. Labor-intensive means of production, although still feasible and probably most appropriate to circum-Titicaca environments, are becoming increasingly difficult to organize and maintain. Without concerted, directed, labor-intensive productive efforts, communities around the lake will most likely become increasingly poor, having to depend to ever greater extents upon imported food stuffs, but with little to offer in exchange. Even the alpaca wool producers and the related artesan production is in jeopardy because as indicated above, continued drought will lead to the decline in pasturage quality and probably quantity. The costs of maintaining herds will consequently increase, and as a result, prices of wool and finished artesan products can likewise be expected to increase. At some point, the demand will peak or supplies will dwindle due to the inability of a native ente. Wool and artesan production may already be contributing to social unrest as an ever-widening gap is forming between those with access to the market (getting richer) and those without such access (getting poorer). This process is widespread in the Andes, and its consequences are well documented (Lewellen 1978; Skar 1982).

Although the development of the Amazon appears necessary for the economic health of many Andean nations, it should be realized that unskilled forest management is having deleterious effects beyond the Amazon basin itself, particularly in the highlands of the Titicaca basin. A subsistence system that operated well for long periods of time is again threatened by drought conditions. This time, however, there appears to be little means for carrying out the necessary intensification of production through labor investment to allow the Titicaca inhabitant to survive the impending crisis. This is unfortunate for the Peruvian and Bolivian governments who are counting on this section of their respective nations to be producing goods for export. It is extremely unfortunate for the people of the Titicaca basin, where large populations and great civilizations developed and lived a stable existence for over 3500 years.

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