Chavimochic: A Peruvian Irrigation Project

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The Chavimochic project is a scheme to construct a massive inter-valley canal system in northern coastal Peru. Promoted as a panacea for drought, it entails drawing water from the Río Santa and transporting it north via tunnels and canals to the Chao, Virú, Moche, and Chicama valleys (Figure 1). At least eight different versions of the project have been proposed since 1912. If built as currently planned, Chavimochic would cost almost $1 billion.

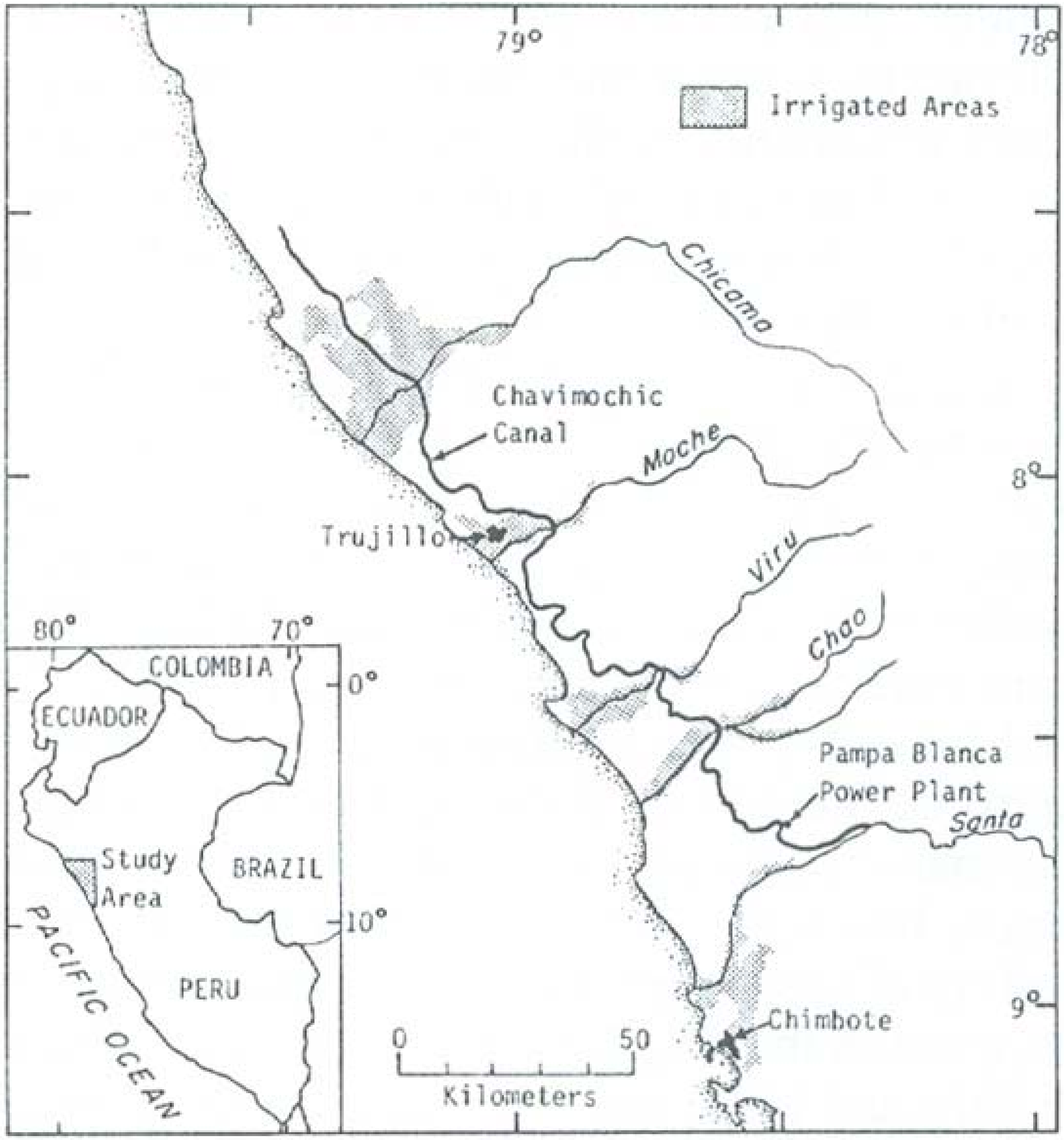

Fig. 1. Route of the Chavimochic Canal.

Proposals to build Chavimochic, accompanied by elaborate publicity campaigns, have served to relieve social and political tensions in northern coastal Peru during droughts. Thus the true function of this project has been to ensure social control and to maintain social stability during times of environmental stress. Chavimochic has, in fact, successsfully diverted public attention from the problems caused by repeated droughts even though little work has been done beyond the planning stages of the project.

The Peruvian North Coast

Basic to an understanding of the Chavimochic project is a brief analysis of the geography of the Peruvian north coastal region, particularly the zone between the Santa and Chicama valleys. This region is a desert, with virtually no rainfall, but it does have great potential for human settlement. Irrigation agriculture, using water from rivers that flow west out of the Andes, has been very productive in coastal

Peru.

In general, the size of the coastal plain in northern Peru decreases from north to south. It is about 25 kilometers wide in the Chicama Valley, about 15 kilometers wide in the Moche Valley, and less than 10 kilometers wide in the Santa Valley. South of the Santa Valley, the coastal plain pinches out and Andean outliers reach the sea. Chicama is the region's largest valley, with a maximum irrigable area of about 50,000 hectares. To the south, the Moche has about 25,000 hectares, the Virú about 12,000 hectares, the Chao about 9,000 hectares, and the Santa Valley about 15,000 hectares. These figures reflect the absolute maximum amount of arable land, not the area currently under cultivation or that actually used at any time in the past.

The water that provides the basis for the region's agriculture comes from precipitation in the adjacent Andean highlands and each river's flow is dependent upon both catchment basin size and the amount of land at high elevation within the valley. Seasonality of flow is determined largely by the timing of precipitation in the upper valleys and by the presence or absence of snowcapped peaks and high mountain lakes, which tend to increase year-round flow rates and to reduce fluctuations in river flows. Within the area under discussion, the Chicama and Santa rivers have the largest catchment basins (the Chicama is of slightly more than 3,000 square killometers and the Santa more than 11,250 square kilometers) and the greatest water flows (the Chicama has an average annual discharge of about 980 million cubic meters and the Santa over 4,500 **[end p. 19]** miIlion cubic meters) (Robinson 1964, 166: ONERN 1973). The Moche, Viru, and Chao rivers are all much smaller, both in terms of the size of their valleys and in the volume of water flow .

Variation in the flow of each north coast river is probably just as important as the average annual discharge in determining the amount of agriculture in each valley. These rivers all have a period of high flow (usually January to May) and a period of low flow (July to November). For the Moche, Virú, and Chao rivers there is often no water available during the dry period. The Río Chicama usually has some flow every month, although this may be minnimal in dry years. The Santa, whose catchment basin includes the highest mountains in Peru and numerous alpine lakes, has the lowest monthly variation of any of the rivers of coastal Peru. The Santa's flow in the driest months is often greater than that of the wettest months of the Moche, Virú, and Chao rivers. Thus, for these five valleys. the smallest rivers have the greatest annual and seasonal flow variations, whereas the largest river has the least flow variation, on both an annual and a seasonal basis.

On occasion, the amount of water available in the north coast rivers is significantly helow the norm for several consecutive years. This results in a *sequia*, or drought, in the region. It is difficult to precisely quantify droughts in northern Peru, howwever, because the lack of rainfall usually associated with a drought occurs in the highland areas east of the coastal plain. Drought in this region must be defined, then, in terms of the consequences of a shortage of irrigation water rather than in terms of the genesis of the drought. It does seem that small valleys such as Chao and Virú are more severely affected than larger ones such as Chicama. Indeed, water availability in the Chao Valley is so unpredictable that firewoorl, rather than an agricultural crop, has often been the major product of this valley (Sutton 1943, 18).

In addition to periodic droughts, two other environmental problems have greatly influenced human occupation of northern coastal Peru: occasional heavy rains (part of the EI Niño phenomenon) and earthquakes or tectonic uplift (Kus 1978). EI Niño rains occur on an irregular basis in northern Peru perhaps on the order of once a decade. Usually these rains are limited to scattered showers during the summer (i.e., December to March) months. Sometimes, however, the rains last for several months and are of great intensity. For example, heavy rains occurred in the Trujillo area (in the Moche Valley) in 1925 and 1983, causing widespread flooding and severe damage. The greatest problems are with *huaicos* or flash floods that flow down some of the norrmally dry stream channels of the region. These floods can destroy roads and such irrigation infrastructure as canals and fields.

Earthquakes and tectonic uplift are a serious threat in the north coast region. Major earthquakes struck the area in 1619, 1725, and 1970, with great damage and loss of life (Lomnitz 1971, 540). Tectonic uplift has altered the landscape several times, with the most recent severe incident dated to about the sixth century A. D. Although the evidence is not absolute. it has been argued that one major effect of tectonic uplift is on the north coast irrigation systems, and that as a result of tectonic activity some canal systems have been abandoned in the region (Moseley 1978; Ortloff 1982, 1983).

Ignoring the problems caused by droughts, earthhquakes. and EI Niño rains, northern coastal Peru is a very pleasant place in which to live. The mean temperature is about 70° Fahrenheit, with summer daytime highs reaching to about 90 and winter night-time lows dropping to about 50. Cooling breezes from the Pacific moderate temperatures and most days are sunny, with heavy cloud cover present only during the winter months. Humidity is high throughhout the region and throughout the year. Average humidity is about 80 percent in areas near the ocean, decreasing inland. In sum, the northern coastal reegion has a very favorable climate for human activity and, when combined with good soils and a plentiful supply of water, has proved to be a very productive agricultural region.

Agricultural History of Northern Coastal Peru

Irrigation agriculture began in northern coastal Peru at least a millenia before the time of the Christ. Over the course of several centuries agricultural sysstems became sophisticated and the range of crops increased. By the beginning of the Christian Era sophisticated canal systems were in use, requiring an elaborate administrative structure to control them. Complex bureaucracies developed (e. g. the Chimú empire), and operation of the irrigation networks became a major function of pre-Hispanic states. In some parts of coastal Peru, long canals were used to link two or more valleys into highly productive units. The succcessful completion of several large intervalley irrrigation systems helped to make the entire northern coast of Peru one of the richest agricultural zones in the New World prior to the arrival of the Europeans.

After the Spanish conquest of Peru, agriculture in the northern coastal region underwent several significant changes. First. the introduction of European diseases depopulated the region and, therefore, reduced the agricultural labor base. Second, the arrival of European plants and animals changed the land, labor, and water requirements of the**[end p. 20]** agricultural systems. For example, sugarcane and rice, important Spanish introductions, had water needs much greater than native cultigens. Finally, Hispanic subdivision of agricultural lands in Peru led to a fragmentation of land tenure and administration that probably had not been present in the pre-Hispanic period.

Other major changes took place in northern coastal Peru between 1880 and 1920. By this time the population of the region had increased to the point where pre-Hispanic population densities were equaled. A long process of unification of fragmented land holdings had begun, centered on large estates growing sugar for export. Small land owners and communal villages lost power and influence to the owners of the large sugar haciendas and to the dominant urban center of the region, Trujillo. This second period of agricultural change culminated with the increasing mechanization of the sugar inndustry and the unionization of the sugar haciendas, along with the rise of the APRA (*Alianza Popular Revolucionaria Americana*) political party (Klarén 1968, 32). Also, by the early part of this century it had become clear that there was insufficient water to irrigate all arable land in northern coastal Peru. Moreover, in times of drought agricultural production suffered drastically. Farms with good access to water, such as the large sugar growers in the region, faced significant crop losses during droughts, whereas those with little or no guaranteed water supply faced ruin when droughts occurred.

In the Trujillo area one solution to the shortage of irrigation water was obvious: the Río Santa. Because the lower Santa Valley is relatively narrow, only a small amount of arable land is available there. The Santa, on the other hand, is one of the largest rivers in coastal Peru and flows mightily year-round. It is understandable, then, why north coast farmers sought to make better use of the Santa's water.

Chavimochic: 1912 to 1961

Several studies of water problems in northern coastal Peru were carried out in the first two decades of this century, but the first to suggest that the Río Santa was the solution to the region's periodic water shortages was made by Eduardo Villarán Godoy and Manuel Flores Romero, Peruvian engineers. They reported in 1912 that water from the Santa could be carried in canals to the Trujillo area. About the same time, an American, C. W. Smith, proposed an alternate plan for carrying Santa water north, via a 20 kilometer long tunnel, which obviously increased the cost and complexity of the scheme (del Carpio 1961, vol. 1, p. 35). In 1918, Victor Larco Herrera, one of the large landowners in the Chicama Valley, began his own project to build a canal north from the Santa Valley. Larco' s construction efforts were quickly frustrated by the Peruvian government, which refused to cede a right-of-way to him (Proyecto Chavimochic 1973). These early efforts to draw water from the Río Santa probably took place during dry years, but the evidence for this is not conclusive.

Between 1926 and 1931 the north coast region experienced a severe drought, and new plans for an intervalley canal were prepared. Studies for this version of the project were completed under the direcction of Efraín Montero and Enrique Góugora. They planned to irrigate 30,000 hectares in the Chao and Virú valleys with a relatively simple canal system from the lower part of the Santa Valley. Work on the Montero/Góugora proposal ended when the world-wide economic depression in the 1930s made the project economically unfeasible. Also, the drought had ended before engineering plans were completed, thus reducing local clamor to initiate construction.

Another severe drought took place in northern coastal Peru in the late 1930s and early 1940s, and interest in the Chavimochic project quickly revived. For the Chicama Valley, 1937 and 1942 were the worst years, whereas in the Moche Valley the drought was very bad from 1936 to the end of 1942 (del Carpio 1961, vol. I, p. 122). During this prolonged drought a new study of the use of Santa water was made by Carlos Sutton, who began work in 1942. He was told to update the Montero/Góuugora proposal for a canal to the Chao and Virú valley. Sutton eventually proposed a very different project from those developed in earlier studies. He advocated the *Ruta Alta* (a route with an intake on the Santa at 405 meters above sea level) for the project, which would allow the canal system to irrrigate the largest possible area (Sutton 1943, 2-5).

The work by Sutton is interesting when compared to the Montero/Gáugora proposal for several reaasons. First, Sutton's 1942 study was the first to include a hydroelectric component. Second, he clearly identified the environmental hazards present in the region, and he discussed several ways to mitigate some of these problems (specifically, the floods caused by El Niño rains) (Sutton 1943, 43). Third, Sutton recognized that it was politically advantageous to propose a project that would benefit the greatest number of farmers, rather than one that was aimed only at the large landowners of the region. He suggested, therefore, that farms of about 15 hectares would be the most efficient in the new agricultural areas (Sutton 1943, 47). Finally, Sutton went beyond his original charge and proposed a canal system that would benefit not only the Chao and Virú valleys, but the Moche and Chicama vallleys as well. Sutton's design would have opened up **[end p. 21]** about 45,000 hectares of new land and improved the irrigation of about 56,000 hectares already under cultivation, of which almost half were in the Chicama Valley (Sutton 1943, 5; Sutton 1944, 1). No construction resulted from Sutton's 1942 to 1944 studies. This was partly because of lack of money for the project, partly because of wartime shortages of materials and equipment, and partly because the long period of drought had ended by the time Sutton submitted his final report. Thus, the immediate need for Chavimochic was gone.

Another drought, in the period 1949 to 1952, once again revived Chavimochic. As had been the case in each previous effort, the first step in the next episode of the project's history was the preparation of preliminary plans. In 1951 a Peruvian engineer, Abel A. LaBarthe, selected a new route for the canal, with less tunneling than either the Montero/ Góugora or Sutton proposals. Engineering drawings based on LaBarthe's proposal were prepared in 1952 by the U. S. firm of Sanderson and Porter (del Carpio 1961, vol. 1, p. 35). Before the plans were commpleted, however, the drought ended and the project was abandoned.

In the middle 1950s drought once again renewed interest in the Chavimochic project (Santa María 1958). This time the Corporación Peruana del Santa, a Peruvian regional development agency, was placed in charge of the project. Field work by the Santa Corporation began in January 1957 and continued sporadically until 1970. By 1961 the Santa Corporation had prepared a set of preliminary plans and had sought international funding for Chavimochic. The total cost at that time was estiimated to be U$89,371,000 (del Carpio 1961, vol. 2, p. 188). The construction of the project was scheduled in four phases. Phase One included construcction of the intake, tunnels, and canals in the Chao and Virú valleys and would have opened 17,505 hectares of new land and improved irrigation of 11,898 hectares. Phase Two involved the extension of the canal system to the Moche Valley, providing 18,606 hectares of new land and improving irriigation of 10,123 hectares. Phase Three was to include extension of the canal system to the Chicama Valley and would have affected almost 80,000 more hectares. The final phase was construction of. a hydroelectric station and installation of a regional power grid. In comparison to Sutton's 1942 to 1944 work, this proposal somehow added about 35 perrcent more land to the area benefited by the project, although the canal systems were almost identical.

Analysis of the Santa Corporation's 1961 version of the project reveals that they did not include the cost of land preparation or of such aspects of agrarian infrastructure as seeds, equipment, housing, roads, and schools within the project costs. These items were estimated at some $55 million (or 61 percent of the basic cost of the project (del Carpio 1961, vol. 2, p. 206). The Santa Corporation also inflated the cost/benefit ratios for the project, particularly for its early phases.

Radar and Associates, a U. S. engineering firm, was hired in 1961 to analyze the Santa Corporation's plans for Chavimochic. The Radar and Associates report, which was highly supportive of the project, urged immediate funding through loans from U.S. sources. Their report also contained an interesting comment regarding the distribution of new lands created by Chavimochic: While there is probably a need for small farms, it is our view that the real hope of efficient production and the improvement of the living standard of the area lies in the mechanization of the farms .... The smallest farm that can be efficiently mechanized is about 28 hectares (70 acres). However, with this equipment the same farmer can efficiently farm 50 hectares (125 acres). The next larger mechanized operation requires a minimum farm of about 41 hectares (100 acres) but will be more efficiently operated with 100 hectares (250 acres) except in those areas of steep slopes where small farms of 6.5 to 10 hectares (16 to 25 acres) will be provided (Radar & Associates 1961, 1-4).

As conceived in 1961, then, Chavimochic was designed to benefit the elites of the region by improving the supply of water available to the large sugar estates and by the creation of many new latifundia in the new agricultural zones. The small farmer, who stood to benefit under the 1942 to 1944 Sutton plan, was relegated to marginal lands in the Santa Corporation's version of the project.

Chavimochic: 1969 to 1985

Land tenure and farming patterns in Peru were radically transformed in 1969 by a new agrarian reform program. In northern coastal Peru the eventual result of this program was the creation of several large agricultural cooperatives. The takeover of the sugar haciendas occurred at a fortuitous moment because world sugar prices then were very high, resulting in immediate profits for the new cooperatives. Also, a drought in the middle 1960s had ended in 1967; during the early 1970s there was an ample supply of water in the north coast rivers. The Chavimochic project had not been actively pursued for almost a decade. Rather, other means of increasing the water supply in the valleys, such as drilling wells, had been fairly successful.

In 1973, at the beginning of another drought in northern Peru, the Chavimochic project was once again revived. This episode in the history of the project was launched by sugar cooperatives in the Moche and Chicama valleys and emphasized the use of the large labor force available on the cooperatives. A new route, with a Santa Valley intake at only 295 meters above sea level, was selected because it was thought to be the easiest to construct using unskilled labor. This route, however, was too low to include a hydroelectric component as part of the project. The new plan was promoted as being easy and quick to construct (it was said that it could be finished within four years). Various estimates of the cost of this version were given; most fell beetween $82 and $100 million ("Chavimochic" 1973; "Visita" 1973).

After 1973, administration of the Chavimochic project passed into the hands of the Peruvian Minnistry of Agriculture. In December 1976 the project was estimated to cost $322 million in its most exxpensive version (the Ruta Alta with a hydroelectric component), whereas the *Ruta Baja* as proposed by the sugar cooperatives (without a hydroelectric plant) was estimated to cost only $289 million ("Memoria" 1977, 1-5). During the late 1970s no monies for construction were allocated, although funds for preliminary studies of Chavimochic were regularly included in the national budget.

In 1981, in the midst of another severe drought in northern Peru, the Peruvian government authorized the expenditure of more than $4 million in preparation for the Chavimochic project. In contrast to previous episodes, however, the 1981 work included such construction efforts as preparation of access roads and construction camps. For 1982, a budget of more than $10 million was requested by the Chavimochic project (which, by then, was an independent entity within the Peruvian governnment). The 1981 version of the project was a modification of Sutton's Ruta Alta, with an intake at 412 meters above sea level and a major hydroelectric facility at Pampa Blanca (designed to generate 64,000 K w of electricity, making it larger than the plants envisioned by either the Sutton or Santa Corporation proposals of earlier years). The 1981 version would have benefited 116,800 hectares (both in new lands and in areas with improved irrigation) and added a new feature--supplying drinking water to the city of Trujillo. The total cost of this proposal was estimated at more than $442 million (' 'Proyecto Hidroenergetico" 1981). The following year, a Peruvian Congressional Commission evaluated the project and declared that it was vital to relieving the severe drought problem in northern Peru. The commission estimated the total cost of Chavimochic as $934 million ("Repuesta" 1982, 20).

In late 1982 and early 1983, public demands for construction of Chavimochic declined dramatically. The long drought of the late 1970s and early 1980s had ended with an adequate water supply in the local rivers available by November or December 1982. By early 1983 it was obvious that a major El Niño event was taking place. Heavy rains fell throughout northern Peru. Under the circumstances, work on Chavimochic came to an abrupt halt and no funding was available for further construction. Once again, the end of an episode of drought reduced interest in this project.

In 1984 and 1985 several proposals were advanced to revive the Chavimochic project ("Irrigación Chavimochic" 1984). In November 1985, a new commission was established to oversee the project, with emphasis on a minimal plan that would first improve the water supply of existing fields and only later add new lands to the project. This version, also, envisioned postponement of construction of hydroelectric facilities to reduce project costs. Beecause of inflation, however, even this scaled-down version of Chavimochic was estimated to cost almost $400 million ("Liberteños" 1985). No source of funding for the project was found, however, and thus it remained in a paralyzed state.

SUMMARY AND CONCLUSIONS

For more than seventy years there have been proposals to build the Chavimochic project in northern coastal Peru. Most efforts to build this inter-valley canal system have come during extended droughts; return of normal water volumes in the region's rivers has usually ended interest in the Chavimochic project. Constant revival of the scheme, however, may serve an important public role in northern coastal Peru beyond its success (or failure) as a transporter of water. Promotion of the project, which has usually included community meetings, newspaper campaigns, and widespread clamor, demonstrates to the public that something is being done to mitigate the effects of drought (Figure 2).

Fig. 2. Typical graffiti in Trujillo, mid-1982.

The APRA political party, for example, has used Chavimochic as a rallying point in elections for more than fifty years. In fact, failure to support Chavimochic has been tantamount to political suicide for candidates in the Trujillo region. There are obviously conflicting mootives for supporting the project among the various publics in the region. Workers on the sugar cooperatives want a more dependable supply of water, as do residents of the city of Trujillo, whereas land-less peasants want water *and* land in the new **[end p. 23]** agricultural areas to be created by the project. Industrialists want electricity, whereas sugar workers are willing to sacrifice construction of a hydroelectric plant if that will reduce costs and speed completion of the project. Politicians have used proomotion of the project to win votes, but after elections must face the overwhelming financial problems of a bankrupt Peruvian economy that has no place for a white elephant such as Chavimochic.

If the true function of the Chavimochic project is seen as a means to ensure social control and maintain social stability in northern coastal Peru during periods of environmental stress, then perhaps the project can be viewed as a success even though no water from the Santa River has ever flowed north to the Chao, Virú, Moche, and Chicama valleys. The promotion of Chavimochic, accompanied by elaborate and well-publicized studies, shows that something is being done to solve the problem of drought in the region. Failure to complete the project allows it to be revived, restudied, and promoted during the next *sequia*.

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