

# RAISED-BED IRRIGATION AT TIWANAKU, BOLIVIA

## Introduction

The Bolivian Altiplano is a high-elevation (over 12,000 feet above sea level), seemingly inhospitable environment. At first glance, it appears an unlikely locale for a flourishing empire capable of supporting a large population. Yet for approximately 600 years, the Tiwanaku Empire thrived on the Altiplano.

The Empire rose about 400 AD, fed by local abundance - fish from the lake Titicaca (the world's highest navigable lake), meat from llamas and alpacas pastured on high plateaus, and potatoes and other crops grown in raised-bed fields fed by irrigation channels and drained by massive ditches. Like other empires, Tiwanaku's expansion depended on abundant food production, and for over seven centuries, it regularly produced food surpluses. These surpluses were a product of ingenious irrigation systems.



Map 1. General Map of the Lake Titicaca region.

According to Andean religion the creator emerged from Lake Titicaca to shape the earth and the first people. Because of its sacred nature, the lake's shores are ringed with the ruins of small shrines and temples, some dating as far back as 700 BC. Researchers think that Tiwanaku (the city) was originally one of these small religious centers.

## Tiwanaku, the Community

But in the 6<sup>th</sup> century, because of the political power of the Tiwanaku people, Tiwanaku became a prize pilgrimage center. Many of these pilgrims traveled long distances, crossing the Titicaca's blue waters on reed crafts. Then they walked due east over the grassy plains of the altiplano toward the blue-and-white peaks of the Andes (see Illustration 2).

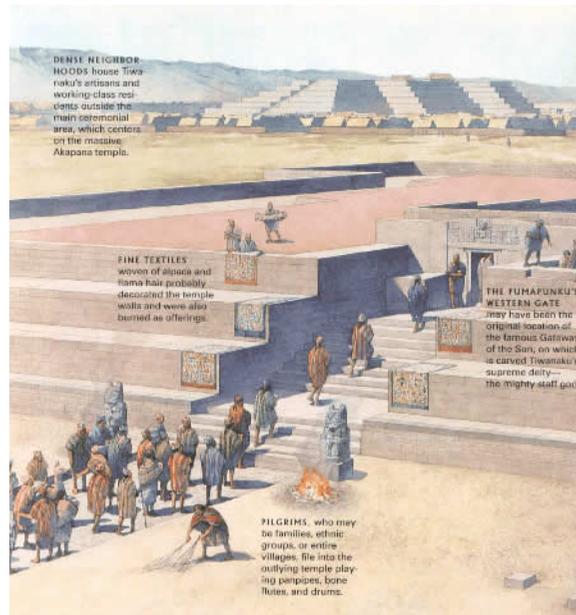


Illustration 1. Pilgrims entering Tiwanaku with Akapana Temple in the background (artist concept from Greg Harlin, National Geographic).

For most of the journey, Mt. Illimani was a beacon. Illimani was their most sacred mountain, where they believed many of their ancestors went when they died. When pilgrims arrived at Tiwanaku, Illimani was before them and Lake Titicaca behind them. The site must have had a strong emotional impact (which was enhanced by drugs), a place between heaven and earth.

Tiwanaku, besides being an large city, contained several large temples which were surrounded by a moat, creating a miniature lake with the temple complex as an island. The central temple, called the Akapana, was constructed in a series of seven tiers, to resemble the nearby peaks. Tiwanaku engineers plumbed the Akapana with drains so that when the annual rains arrived, water would thunder through it. "It was a way of renewing the earth and maintaining the circulatory system of the universe," says Alan Kolata, a University of Chicago archaeologist, who thinks the Tiwanaka probably celebrated fertility ceremonies and other rites while water roared through their mountain-temple (see Photograph 1).



Photograph 1. Kalasasaya temple complex at Tiwanaku.

## Raised-Bed Irrigation

At their peak between 700 AD and 1000 AD, the Tiwanaku Empire controlled nearly entire Lake Titicaca basin as well as extensive holdings in Peru and Chile. Their engineers and farmers turned the broad valley of the Katari River, a tributary of Titicaca, into their breadbasket, using extensive canals and causeways to irrigate a vast area of corn, potatoes, quinoa, and other crops. "They actually altered the meanders of the river," says John Janusek,

an archaeologist at Vanderbilt University who excavated several Tiwanaku settlements, "and turned it into a straight shot through the valley."

A 32-year drought from 563-594 AD caused widespread devastation across empire. There is evidence, however, that a lesson was learned. The rulers took the catastrophe as a warning. They revolutionized their agriculture, instituting a totally new system which, some believe, allowed the empire to prosper for an additional 400 years. In any event, Tiwanaku agricultural surpluses after the drought can be attributed to raised-bed irrigation. Water surrounded raised agricultural mounds (see Photograph 2).



*Photograph 2. Modern-day raised-bed irrigation systems at Tiwanaku.*

Warmed during the day, the water kept the crops from freezing during the cold Andean nights and even extended the growing season. Raised-bed agriculture grew to encompass an immense area, at least 19,000 hectares (47,120 acres). Studies show that land cultivated in this manner could yield 20 metric tons of potatoes per hectare. Construction of the raised-bed irrigation system no doubt required major earth moving operations.

## **Fall of the Empire**

The German adventurer Arthur Posnansky explored Tiwanaku in 1904 and, his 1945 monumental two-volume book attributed its decline to "malign climate conditions." Indeed, the historical record confirms that Andean climate can be malign.

Climatological data developed by Lonnie Thompson from the Quelccaya Ice Cap in Peru indicates a decrease in precipitation between 650 AD and 730 and between 1245-1310. High dust concentrations peaked between 600-920 coinciding with periods of massive field construction. Also beginning in 1000 there was a rise in the mean temperature (between 0.5 and 1 degree). Kolata suggests that this is the beginning of the Little Ice Age, which caused a serious drought resulting in agricultural collapse and ultimately the demise of the Empire.

Kolata's version of the decline and fall of the Tiwanaku Empire, however, is not the only one. Another theory holds that the demise resulted from a fracturing of the belief structure and trade systems, starting at the periphery and culminating in the abandonment of the pilgrimage center at Tiwanaku. But even if you buy the latter argument, its hard to dismiss the evidence of environmental determinism.

## **References**

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