

Terraces

Background

For thousands of years, the engineering needs for crop irrigation have strongly impacted civilizations. In the eyes of some academics, those needs were responsible for the creation of the first civilizations. Karl Wittfogel, an American historian, first coined the expression "hydraulic societies" to describe the complex hierarchical civilizations that evolved from the need to irrigate. He argued that they emerged specifically to organize the large labor forces necessary to create and maintain their complex water-supply systems.

Perhaps the most scenic and exotic these irrigation works are the terraced mountainsides (see photograph 1). Terraces are the product of massive highly organized human efforts. They turn mountain slopes into oversized "stairsteps" of narrow fields, each held up by a retaining wall. Each step is irrigated by water transported down the mountainside from springs, rivers, or reservoirs, using a complex network of canals, sluices, and pipes. The terraces allow the hillside to be cultivated with a minimum of soil erosion; they serve to keep irrigation water on the fields.



Photograph 1. The rice terraces in northern Luzon, Phillipines, are some of the most spectacular in the world.

Asia (from Fred Pearce in *Eurozine*)

Growing rice—Asia's most important crop—on hillside terraces is one of the most characteristic activities of southeastern Asia. According to the British anthropologist and traveler, John Reader, most of the continent's rice is eaten within walking distance of where it is grown. The richness and importance of this crop goes a long way to explaining the continent's high rural population. Certainly no other civilizations have proved capable of sustaining such dense populations.

The reason for this is fairly straightforward. While growing rice on irrigated terraces is labor-intensive, it is also highly productive. In the rich soils of islands such as Java and Bali, all part of Indonesia, the rice terraces feed upwards of a thousand people per square kilometer. The narrow paths between the terraces limit the types of farm machinery that can service the fields. Everything from tilling to harvesting must be done by hand.

But to achieve this high productivity with little mechanization, farmers have evolved complex and, to many eyes, regimented social structures. The needs of the individual have to be subordinated to the communal will. On a terrace system, farmers cannot grow their rice when they want. Growing has to be staggered so the water supply can be shared efficiently—so that some terraces are at the dry stage while others are being flooded. To break ranks would be disastrous.

In Bali, for instance, there is a separate village organization known as the subak or "irrigation society" that determines who plants when. According to American anthropologist Clifford Geertz, there is one subak for each water source. Each branch of the distribution canal from that source also has its own neighborhood organization. Every activity in the management of water and crops is written into the village religious and secular calendar.

Work associated with the terraces determines the nature of the society. As Reader puts it: "People must work together in a very well organized and coordinated manner, building and maintaining terraces, ensuring adequate water flow, synchronizing the planting and tending of the crops." The process is virtually self-perpetuating, he

says. Confined to a limited patch of land, the culture turns in on itself. Practices become ritualized in religious and social behavior. "The threads run so tightly through all aspects of the society and culture that they have proved remarkably resistant to external attempts to pull them apart."

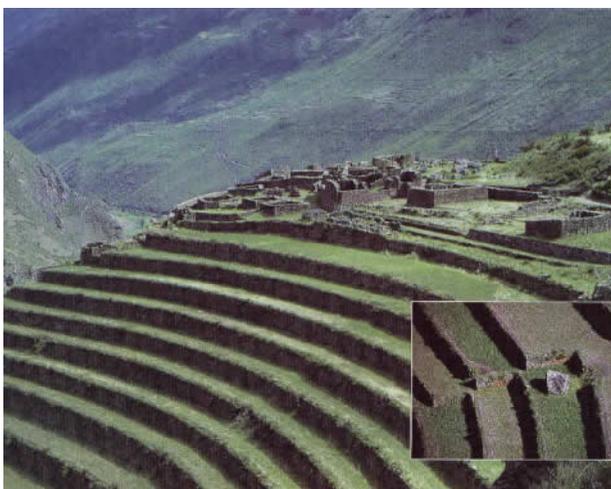
In essence, the rice-terrace culture of Bali has been unchanged for more than a thousand years, absorbing first Hinduism from Indian and later Dutch colonial and Western cultures. Having to work so intensely together to feed themselves can turn an individual into a mere cog in a wheel, says Reader. Personal identity is lost, replaced by a profound fatalism. "People come and go, but the system persists."

Among the most spectacular examples of terraces are the rice fields that cover much of northern Luzon (the largest island in the Philippines). Often dubbed the "eighth wonder of the world", they were among the first of these ancient works to gain modern recognition from both archaeologists and tourists.

Not everything is wonderful with the Asian terraces, however. Travel the foothills of the Himalayas in northern India, for instance, and you will see abandoned terraces. Many people buy food bought with money sent home by relatives working in the cities. The men and women who stay behind are more likely to take laboring jobs making the numerous roads now being constructed through mountains than to till their hillsides.

South America

Mountainside terraces are a global phenomenon; a similar technology developed in the New World. And on both continents they seem to be associated with centralized societies. The most famous of the Inca terraces are at Machu Picchu (see photograph 2). The agricultural terraces of this Inca royal retreat are both physically and aesthetically astounding. In the mountainous jungle terrain of Peru, the terraces created fields for crops and also provided protection from uncontrolled runoff and hillside erosion.



Photograph 2. The Inca landscaping at Pisac, Peru, was designed with eye-pleasing terraces that protected the steep hillsides from erosion while also providing flat land for agriculture.

The fields created by the ancient agricultural terraces at Machu Picchu totalled only a few acres. The terraces are formed by stone retaining walls, contain thick topsoil, and are well drained. Field investigations conducted over several years by Kenneth Wright, P.E., and his colleagues found no evidence that the terraces were ever irrigated. However, evidence was found that agricultural drainage water, along with basin subsurface runoff, was captured for several fountains located downhill from the royal retreat.

Located 20 miles east of Cuzco, Peru, is another terraced marvel, the Tipon Archeological Park. Unlike Machu Picchu, here the Inca irrigated significant areas. Inca engineers understood crop water requirements at both Machu Picchu and Tipon, and the relationship of precipitation to the necessary moisture for growing crops. For instance maize at Machu Picchu was not irrigated, while maize at Tipon was, the difference being the quantity of rainfall which fell at each site (822 mm per year at Tipon and nearly 2,000 mm per year at Machu Picchu).

In the Andes, the Incas and their predecessors created magnificent systems of stone-walled terraces that cover around a million hectares of present-day Peru. Unfortunately, today, more than half of the terraced fields are abandoned, as the hills are being depopulated and millions have moved, in poverty, to the capital of Lima.

Conclusions

From Afghanistan (see Nuristan), to the Philippines, to Peru (see Machu Picchu), the world's terraces and water systems that feed them are superb examples of sustainable land use, allowing a high-density population to live in what appears to be an inhospitable terrain. But this concentration of people must, by necessity, live a fairly regimented existence.

References

Pearce, F., 2001, "Terraces: The Other Wonders of the World," *Eurozine*, March.

Wright, K. R., R. H. Wright, A. V. Zegarra, and G. McEvan, 2001, *Tipon: Water Engineering Masterpiece of the Inca Empire*, Final Report No. 344-NC-C-2000, Wright Paleohydrological Institute, Denver, Colorado, April.

Wright, K. R., A. V. Zegarra, and W. L. Lorah, 1999, "Ancient Machu Picchu Drainage Engineering," *Journal of Irrigation and Drainage Engineering*, November/December.