

Life-Saving Feats of Engineering: Nascan Puquios

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To sustain a civilization, a veritable abundance of resources is required to keep all its inhabitants alive and nourished, the most important of which would arguably be water, a substance that all living organisms need to continue living. This poses a significant problem, however, for people seeking to inhabit arid places in the world where access to water is scarce. They would have to devise a means to gather enough water to keep themselves alive, which would be especially difficult for people of the past who did not have the powerful technologies modern people do. However, this is exactly what the Nasca people of southwestern Peru did. They managed to build elaborate aqueduct systems to siphon water from underground, called puquios. The puquios made by the Nasca people were an ingenious way to solve a water crisis, the construction of which exhibits skills and designs they are shown to utilize in their other creations.

The Nasca was a culture from around 100 to 800 AD, residing in the Chincha, Pisco, Ica, Nazca, and Acari valleys near the southwest coast of Peru.¹ Their proximity to the ocean was quite a blessing for them, with it harboring a major food source with its abundance of fish and other marine life. Freshwater, however, was another issue. Many parts of southwestern Peru were hot and dry deserts, owing to it being unluckily situated in a place where cold ocean currents caused there to be very little rainfall.² Rivers in Peru were also few and far between, notable ones being Rio Pisco, Rio Ica, and Rio Grande de Nasca.³ Access to them was especially difficult for the Nasca valley area, to the point where etymology suggests that even Nasca's name originated

¹ Luis Lumbreras, *The Peoples and Cultures of Ancient Peru*, trans. Betty Meggers, (Washington: Smithsonian Institution Press, 1974), 122.

² Katharina Schreiber and Josue Rojas, *Irrigation and Society in the Peruvian Desert: The Puquios of Nasca* (Maryland, Lexington Books, 2003), 21.

³ Henri Stierlin, *Nazca: la clé du mystère* (Paris: Albin Michel, 1983), 80.

as a reference to its lack of water – a legend in 1982 describes dehydrated valley residents crying “nanay” to their gods. Nanay is the Quechua word for pain, which eventually evolved into

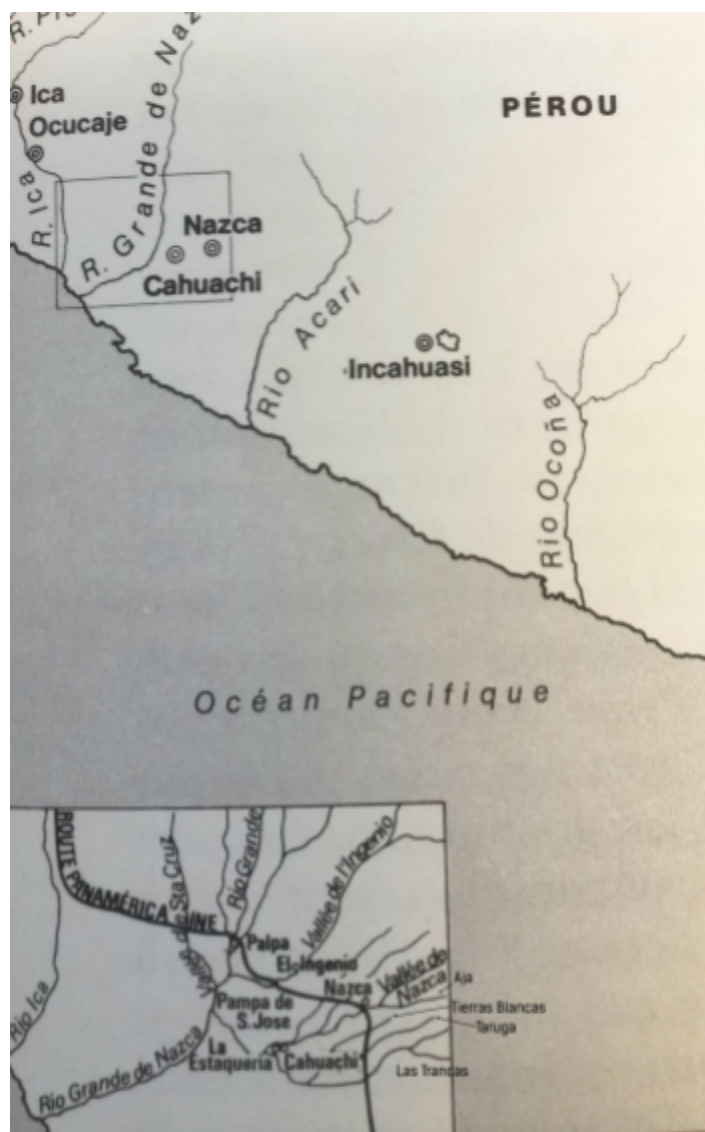


Figure 1. Peru and its major rivers with closeup on the Nasca valley area, from *Nazca: la clé du mystère*, pg. 21 (Paris: Henri Sterlin, 1983).

Nasca.⁴ As Fig. 1 shows, the major rivers near the coast of Peru include the Rio Pisco, Rio Ica, Rio Grande de Nasca, and Rio Ocona. The closest one to the Nasca region is the Rio Grande de Nasca, which branches off into several smaller rivers, such as the Ingenio and the Aja. Although the Nasca region may look close to several rivers by the map, these offshoot rivers barely hold any water compared to Rio Grande, as shown by Fig. 2. Much of the Nasca region such as the Nasca valley and south of it are close to rivers such as the Aja, Tierras Blancas, Taruga, and Las Trancas, as shown by Fig. 1, but Fig. 2 indicates these rivers are the ones holding the least water.

When geographer Clement Markhams toured the area in the 1800s, he described these

⁴ Gary Urton, “Report of Fieldwork in Nazca, Peru” (manuscript, New York, Colgate University, 1982), 10-11.

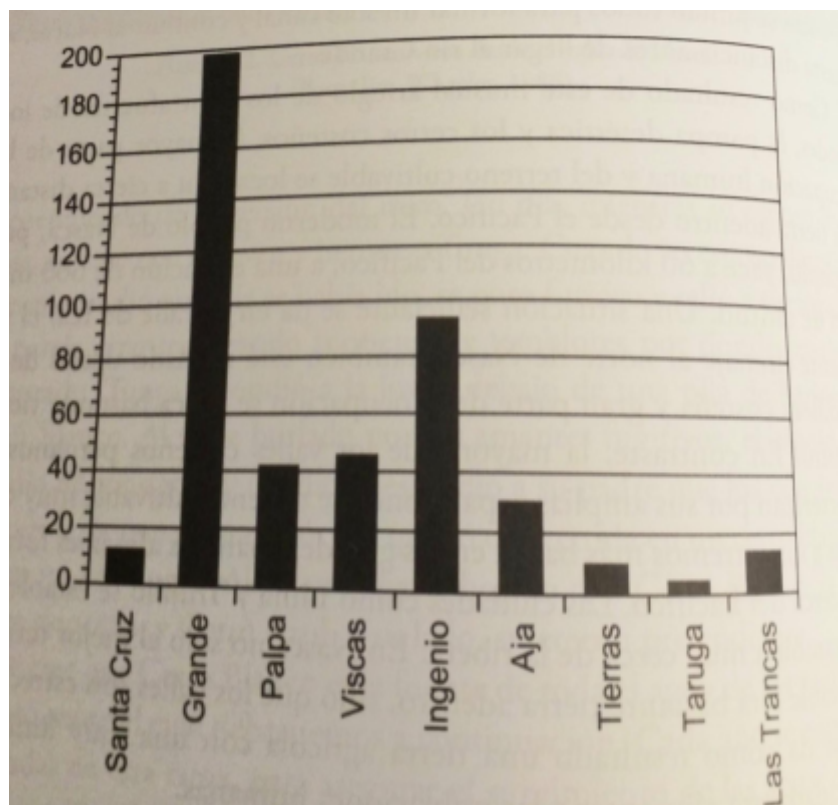


Figure 2. Average annual discharge from Rio Grande de Nasca and its offshoots in million cubic meters, with rivers organized from northmost to southmost, from *Los Puquios de Nasca*, pg. 40 (Lima: Katharina Schreiber & Josue Rojas, 2006)

“watercourses” as being “almost always dry.”⁵ As such, people living in the Nasca region had no choice but to get a source of water from elsewhere. One solution would be to irrigate from northern rivers, and while irrigation canals pulling directly from rivers are not unheard of, such as the one found connecting Las Trancas to the more plentiful Aja river, they are rather rare. One

theory suggests that irrigating from Ingenio or Grande would cause the people living there to have power over the Nasca, which they wanted to avoid.⁶ Because of this, and the difficulty in creating such long canals, the Nasca people found it simpler to tap the ground for groundwater.⁷

Because of the above as well as climate change making the area more and more arid, the construction of puquios is estimated to have started around 400-500 AD.⁸ Puquios are very

⁵ Clements Markham, *Markham in Peru: The Travels of Clements R. Markham, 1852-1853*, ed. Peter Blanchard (Texas, University of Texas Press, 1991), 50.

⁶ Persis Clarkson, and Ronald Dorn, “New Chronometric Dates for the Puquios of Nasca, Peru,” *Latin American Antiquity* 6, no. 1 (1995): 66.

⁷ Schreiber and Rojas, *Irrigation and Society in the Peruvian Desert: The Puquios of Nasca*, 32-33.

⁸ Clarkson and Dorn, “New Chronometric Dates for the Puquios of Nasca, Peru,” 57.

similar in construction to other aqueducts such as West Asian qanats, though no sources indicate influence between Nasca and other cultures. While designs of individual aqueducts may vary, they all operate by taking advantage of gravity to move and collect underground water. To do that, puquios are generally built using sloped or hilly areas, which Nasca valley, having an abundance of coastal hills nearby, could utilize.⁹ This is because if the ground is sloped, the aquifer, or the part of the underground that holds water, should be as well. Trench or tunnel shaped aqueducts are then excavated, cutting into the aquifer so that water can collect in them. The aqueducts, which are nearly horizontal with a slight downward slope, lets the water flow to the other end, which leads out of the hill and into wherever water is needed, such as feeding into larger irrigation canals, called acequias, or into reservoirs, called kochas.¹⁰ This is illustrated in Fig. 3.

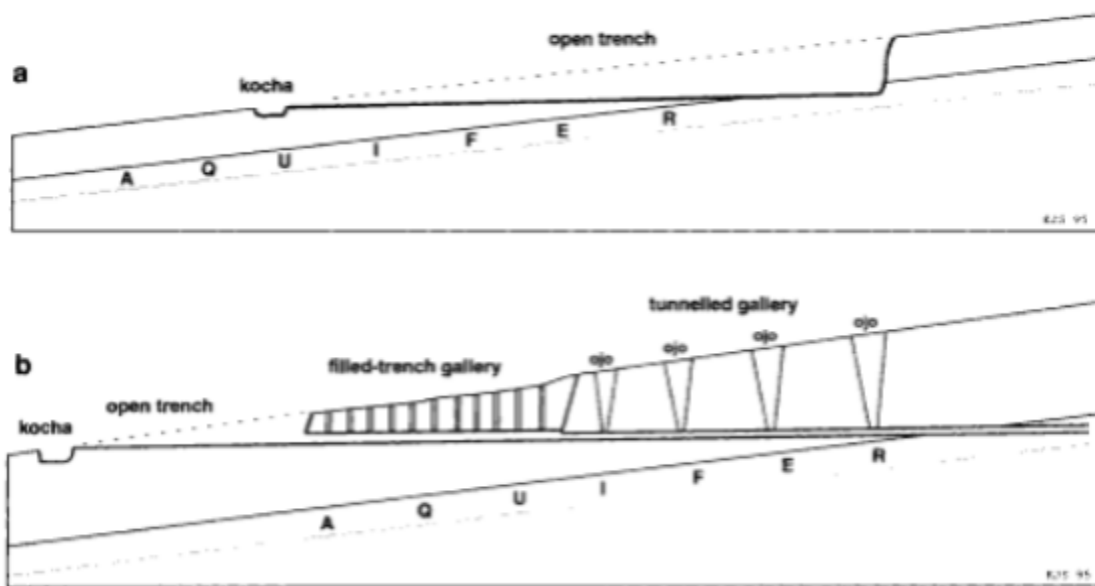


Figure 3. Schematic of how puquios work, showing two different types, from “The Puquios of Nasca”, *Latin American Antiquity* pg. 234 (Cambridge: Schreiber & Rojas, 1995)

⁹ Schreiber and Rojas, *Irrigation and Society in the Peruvian Desert: The Puquios of Nasca*, 32-33.

¹⁰ Katharina Schreiber and Josue Rojas, “The Puquios of Nasca,” *Latin American Antiquity* 6, no. 3 (1995): 234.

The figure also shows different types of puquios being constructed. Fig. 3a shows a type of puquio that is just an open trench. Ten of these have been found in Nazca valley, and they are usually shorter and shallower than other types of puquios. This likely is because while the excavation of trenches would be simpler and less perilous than tunnels, as the diggers would not have to worry about them collapsing, it would also require much more labor given how much more earth needed to be dug out to construct them. Fig. 3b illustrates a puquio using tunnels. These types of puquios are more common than the trenches and they often are much bigger as well; one of them in Santa Maria in the Taruga Valley measures well over 350 meters in length.¹¹ Aside from the horizontal tunnels, vertical shafts that reach to the tunnels were also periodically dug along its length, about every 200 yards. These conical shafts are called “ojos”, the Spanish word for eyes, due to their resemblance. They provided access to the tunnels, which was useful when people needed to clear blockages from the waterways, as it was easier and safer to dig a new ojo into the tunnels than to go through them to get to the obstruction.¹² Not only that, but ojos can also funnel wind into the tunnels to keep the water flowing effectively into drainage sites.¹³

The labor and engineering that went into the puquios ultimately worked out rather well for the Nasca people, as evidence shows that directly following the start of the puquios’ construction, there was an increase in settlements in areas thought previously uninhabitable due to excessive aridity and lack of water access. Markham, the geographer who toured Peru in the

¹¹ Jaroslav Šedina, Martina Hůlková, Karel Pavelka, and Karel Pavelka, Jr, “RPAS for documentation of Nazca aqueducts,” *European Journal of Remote Sensing* 52, no.1 (2019): 174-181.

¹² Schreiber and Rojas, “The Puquios of Nasca,” 235.

¹³ Šedina et al. “RPAS for documentation of Nazca aqueducts.”

1800s mentioned earlier, also said that Nasca was “the most fertile and beautiful spot on the coast of Peru”, producing “fruits and vegetables of excellent quality in abundance.”¹⁴ As of today, 36 puquios are still fully functional. Some are being used as tourist attractions such as the one in Cantalloc, and others, such as the ones in Santa Maria and San Carlos, are being used to irrigate fields even now.¹⁵ The construction of puquios has, in no small part, resolved the water crisis in the coast of Peru using its innovative method of drawing out groundwater.

The impressive aspect about puquios is the sheer technological feat required to build them. Many of them span well over 200 meters, with some spanning over 500.¹⁶ To build tunnels of such length while also precisely determining where it should lead to, especially without modern aerial technologies, would require a very good sense of spatial acuity on the part of the designers and excavators. One thing that is interesting to note, however, is that said spatial acuity

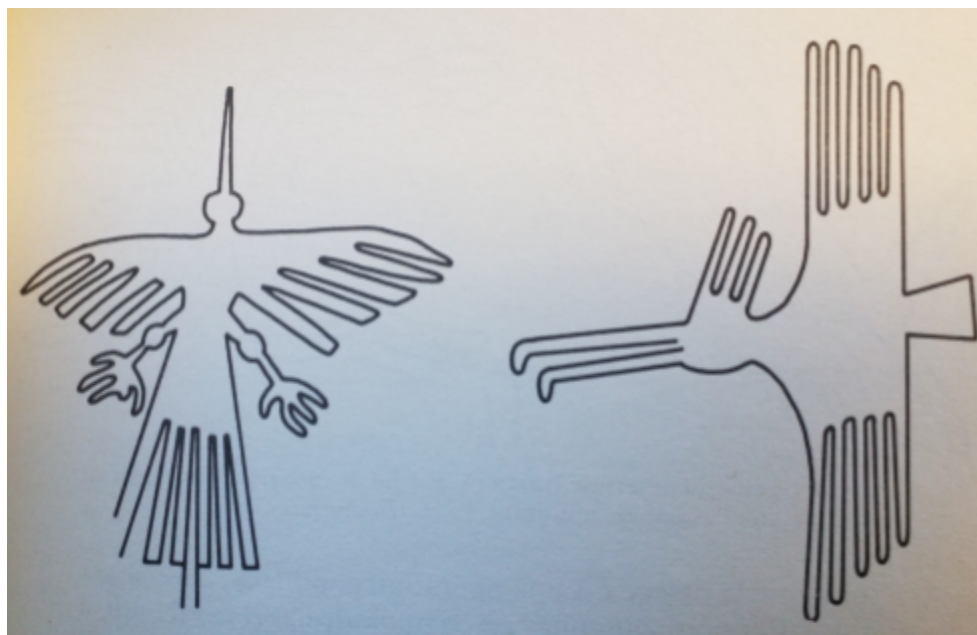


Figure 4. Illustrations of the condor and pelican Nasca Lines, with the condor being 135 meters in length and pelican 105, from *Nazca: la clé du mystère*, pg. 157 (Paris: Henri Sterlin, 1983)

was also needed for the creation of the Nasca Lines. The Nasca Lines, one of the more well-known artifacts to come from the Nasca culture, are a set of large designs

¹⁴ Markham, *Markham in Peru: The Travels of Clements R. Markham, 1852-1853*, 50.

¹⁵ Šedina et al. “RPAS for documentation of Nazca aqueducts.”

¹⁶ Schreiber and Rojas, *Agua en el Desierto: Los Puquios de Nasca*

inscribed on the ground of the Nazca Desert. Their creation predates that of puquios by quite a bit, being constructed before 500 AD. Their designs range from simple shapes, such as zigzags or spirals, to representations of animals such as hummingbirds and monkeys. Depending on the type of design, individual geoglyphs can span from 100 to 1000 meters in length, as shown in Fig. 4. Each design is made out of one continuous groove. Because of that, it implies that there were little to no modifications to the design after the fact that would disrupt the continuity of the groove, meaning the inscribers managed to carve it out on their first try. Given the sheer size of the design, the construction of the Nasca Lines was quite an impressive feat considering how they managed to precisely draw such complex designs without the aerial technology required to see the whole. There are many theories as to how the Nasca Lines were planned out, such as via ropes tied to stakes or using grid systems.¹⁷ Regardless of the exact method, though, the Nasca Lines' existence indicates that the Nasca society had the spatial acuity, technology, and skills to dig large scale designs in the Earth, which the Lines and puquios essentially both are. Given this similarity between the two, perhaps the Nasca people drew upon their experience creating the Lines to construct the puquios.

Another aspect to note about puquios are their appearances, especially the ojos'. Puquios trenches, tunnels, and ojos are generally lined with something, such as stone or sometimes masonry, to prevent reabsorption of water back into the earth.¹⁸ The shape of ojos also can vary by location, including shapes like rectangles, sometimes supported by wooden beams (Fig. 5a),

¹⁷ Joe Nickell and James Randi, "Mystery of the Nazca Lines," *The Mystery Chronicles: More Real-Life X-Files* (2004): 1-3, 6

¹⁸ Clarkson and Dorn, "New Chronometric Dates for the Puquios of Nasca, Peru," 59.

or more commonly, conical spirals (Fig. 5b), which begs the question of why builders would

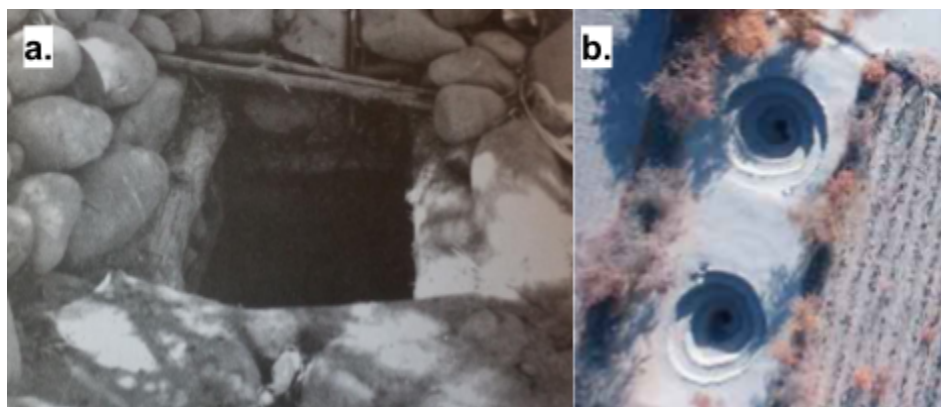


Figure 5. 5a shows an ojo from Huairona, from *Los Puquios de Nasca*, pg. 67 (Lima: Schreiber & Rojas, 2006), 5b shows ojos from Cantalloc, from “RPAS for documentation of Nazca aqueducts” (England: Šedina et al., 2018). Both are located in the valley of Tierras Blancas.

construct them in such a shape given its complexity compared to vertical wells like 5a. While spiral shapes may facilitate the funneling of wind

into the aqueducts, because the ojos are primarily used as a way of access into the aqueducts, there should not really be any reason to go through the trouble of creating a spiral when simple wells would have sufficed other than aesthetics.¹⁹ There is precedent for the theory of spiral ojos being constructed like that for aesthetics, as early buildings in Nazca in the site of Cahuachi also tended to be made out of conical adobes.²⁰ Spirals were also a common detail in Nascan art, such as in Nasca Lines, most notably that of the spiral tail in the monkey design. Spirals and circles also tended to show up in pottery. Masonry, which was sometimes utilized in puquios themselves, was something that the Nasca culture became very well known for, as their ceramics, emblazoned with vivid images, are studied by archaeologists to this day. Fig. 6 shows two pottery vessels by the Nasca people that heavily utilizes circular and spiral-shaped designs that highly resemble the ojos shown in Fig. 5b. Because of this, it is likely that ojos like the ones in Cantalloc utilizes existing design principles common in many forms of Nascan art in its architectural design.

¹⁹ Šedina et al. “RPAS for documentation of Nazca aqueducts.”

²⁰ Lumbreras, *The Peoples and Cultures of Ancient Peru*, 123.

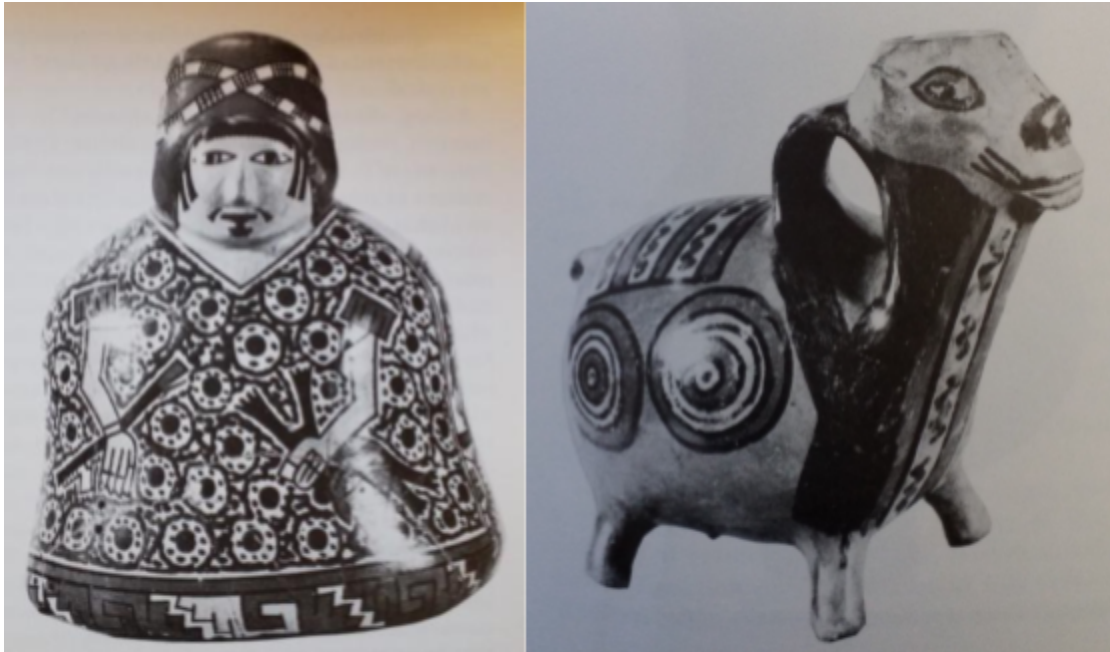


Fig 6. Two pieces of pottery from Nasca. Note the circular designs on both. From *The Peoples and Cultures of Ancient Peru*, pg. 131 (Washington: Lumbreras, 1974).

While the puquios may not have been directly inspired from Nascan pottery or Nasca Lines, they do share aesthetic similarities, and all three definitely required skill on the parts of their makers to create, especially the spatial acuity and labor required to dig out the Nasca Lines and long-spanning puquios. Still, the labor put into the puquios definitely had high returns, with people being able to do large scale agriculture and expand into uncharted places thanks to them. With puquios, the Nasca society was able to fill an arid desert with lush greenery that it still has to this day.