

Landforms of Titicaca

Near Sillustani

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This book is dedicated to my grandmother, Carolina Dastrù.

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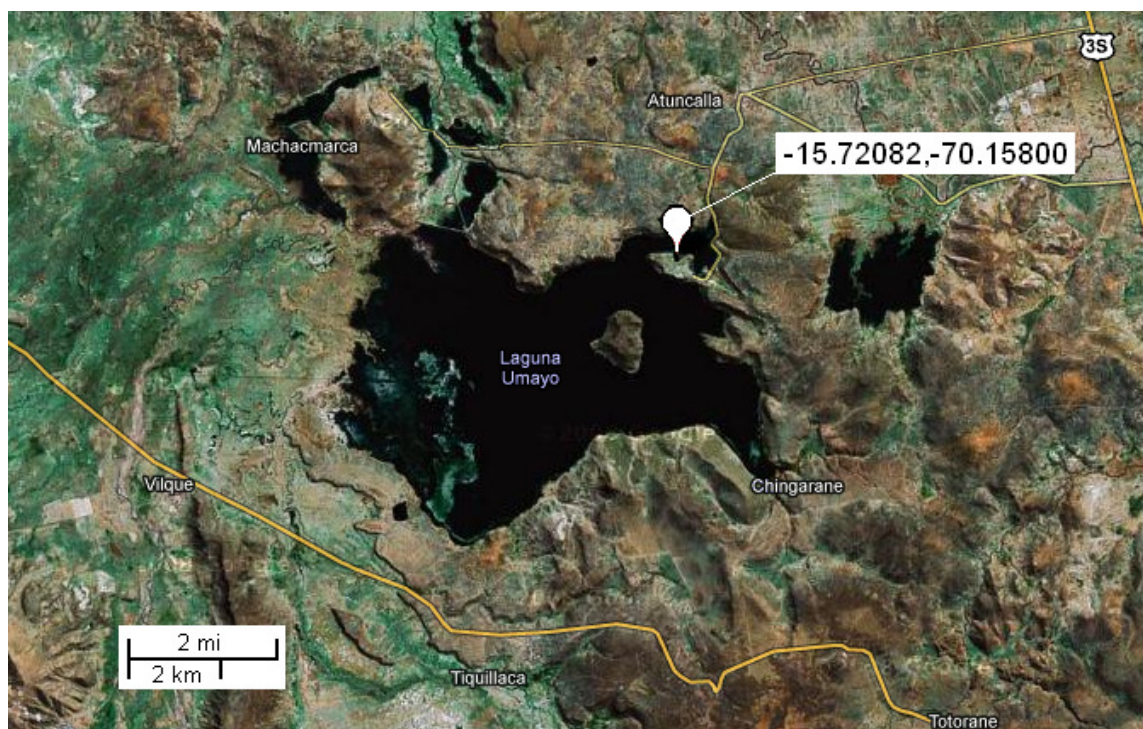
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Terraced hills, a network of earthworks, sometimes creating geoglyphs, and ancient ruins are the structures we can observe with the satellites imagery of Google Maps. After the previous publications on the earthworks and geoglyphs ¹, let us survey specific area with more details. Here we show satellite imagery, enhanced with freely available image processing software, of the area near Sillustani, the peninsula of the Laguna Umayo, in Puno region of Peru. Besides Sillustani, interesting places are the Mesa Isla, Atuncalla and Machacmarca. The images we show are coming from the Google Maps (in few cases from the ACME Google service). The coordinates are inserted in the images, and also the scales.



Sillustani is the peninsula marked with the white label in the figure. At the top of the peninsula there is a tall chullpa, about 12m high.

According to scholars, Sillustani is a pre-Incan burial. Tombs are built above ground in tower-like structures called chullpas. These structures were built by Colla people, Aymara, who were conquered by the Inca in the 15th century. The structures housed the remains of complete family groups, although they were probably limited to nobility ².

Wikipedia is reporting several interesting information on chullpas, that the ancestor worship

¹ Symbolic landforms created by ancient earthworks near Lake Titicaca, A.C. Sparavigna, 12 Sept 2010, Geophysics (physics.geo-ph); Graphics (cs.GR); arXiv:1009.2231v2 [physics.geo-ph]; Geoglyphs of Titicaca as an ancient example of graphic design, A.C. Sparavigna, 23 Sept 2010, Graphics (cs.GR); arXiv:1009.4602v1 [cs.GR]; Geoglyphs of Titicaca, A.C. Sparavigna, Lulu Enterprises, 26 Sept 2010, <http://www.scribd.com/doc/39011733/Book-Geoglyphs-Titicaca-Sparavigna>

² Stanish, Charles. Ancient Titicaca. University of Columbia Press. ISBN 0-520-23245-3.

and kinship were integral parts of Aymara culture and that the insides of tombs were shaped like a woman's uterus, and corpses were mummified in a fetal position to recreate their birth. The only openings to the buildings face east, where it was believed the Sun was reborn by Mother Earth each day. Another interesting remarks is on the architecture of chullpas. Wikipedia is telling that "the architecture of the site is often considered more complex than typical Incan architecture. In contrast with the Inca, who used stones of varying shapes, the Colla used even rectangular edges. While chullpas are not unique to Sillustani and are found across the Altiplano, this site is considered the best and most preserved example of them".



The figure shows details of Sillustani. Note the circular structure of the tower.



Here again a detail of Sillustani. The upper image is that obtained from ACME mapper, the lower the same images after a processing with a wavelet filtering. As discussed in a previous paper³, it is possible to use several free software for image processing, able to increase

³ Enhancing the Google imagery using a wavelet filter, A.C. Sparavigna, 8 Sept 2010, Geophysics (physics.geo-ph); Earth and Planetary Astrophysics (astro-ph.EP), arXiv:1009.1590

The island of the Umayo Lagoon is the Mesa Isla. Is this another burial place?

From the Google satellite imagery, it appears as a mythic Avalon, the legendary island of the Arthurian legend. Avalon was the place where King Arthur's sword Excalibur was forged and later where Arthur is taken to recover from his wounds after the Battle of Camlann. Avalon has parallels elsewhere in Indo-European mythology, as the Greek Hesperides, also noted for its apples. It would be interesting to know whether similar tradition for the Mesa Isla are known or not.



From a web site⁴, we understand the “current theory about Andean mortuary practices focuses on the connections between the living and the deceased, and their relationship to the landscape and built environment. Ancestor worship permeated all levels of Andean society from the local community to the Inca state. Andean people venerated and buried their deceased in many ways. In the altiplano of Bolivia, the Aymara people placed some members of their society in monumental structures of stone and adobe known as chullpas. Throughout the Sajama region, lines or ritual pathways are etched into the landscape. The ethnographies of the area suggest a link between the lines and some cultural features... The research will also address other possible associations between chullpas and the cultural landscape.”

⁴ http://cml.upenn.edu/tierrasajama/Sajama_English/hypo/chullpa.htm



The center of the Mesa Isla: it seems that there is a chullpa at the top of the island.



The hills of the area near the Umayo lagoon are terraced. Note that the terraces are carefully following the slope of the hill. In this image we see that at the top of the hill, at the middle of a field, two isolated heaps or piles of stone. One of the has a circular shape as the tower of Sillustani. According to the previous discussion on burial places, we could argue that these can be monuments for ancestors too.



Here we see terraced hills and waru-waru.

A huge network of earthworks (waru-waru is the local name) covers the land near the Titicaca Lake, being the result of an almost unimaginable agricultural effort of ancient Andean people. People created a system of raised fields, which were large elevated planting platforms, with the corresponding drainage canals, to improve soil conditions. The engineering abilities of the peoples who lived there in pre-Columbian times is impressive. In 1981, Clark Erickson, University of Illinois, recognized the significance of waru waru. He and other researchers started an experimental reintroduction of raised fields⁵. The raised fields of Titicaca have different forms and size, generally being 4-10 m wide, 10 to 100 m

⁵ Raised field agriculture in the Lake Titicaca basin, C.L. Erickson, Expedition, Volume 30, 1988, Pages 8-16

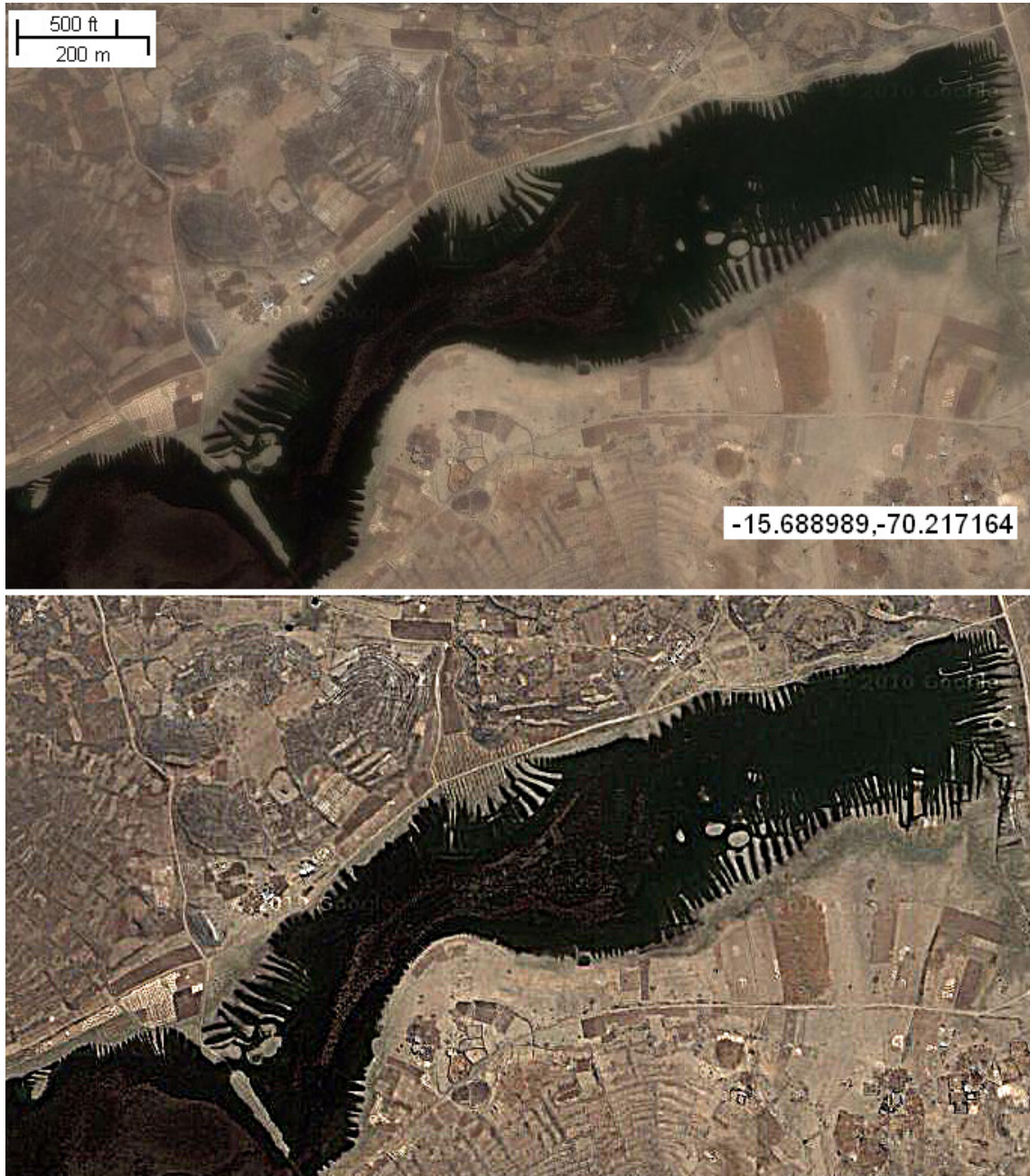
long, and 1 m tall. In spite of erosion, the network of these not so-high earthworks is clearly visible from the space, with geoglyphs distributed in the network⁶.

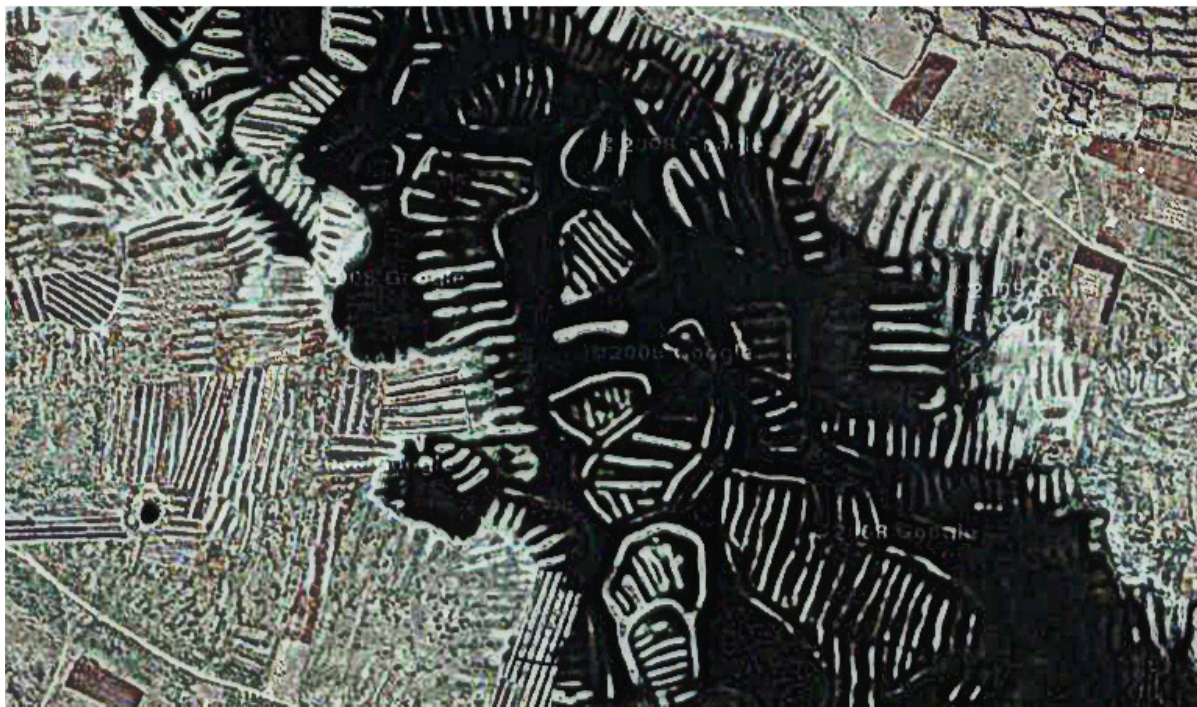
In the following image, an area of Machacamarca, with a terraced hill, waru-waru and a curious canal which looks as a snake.



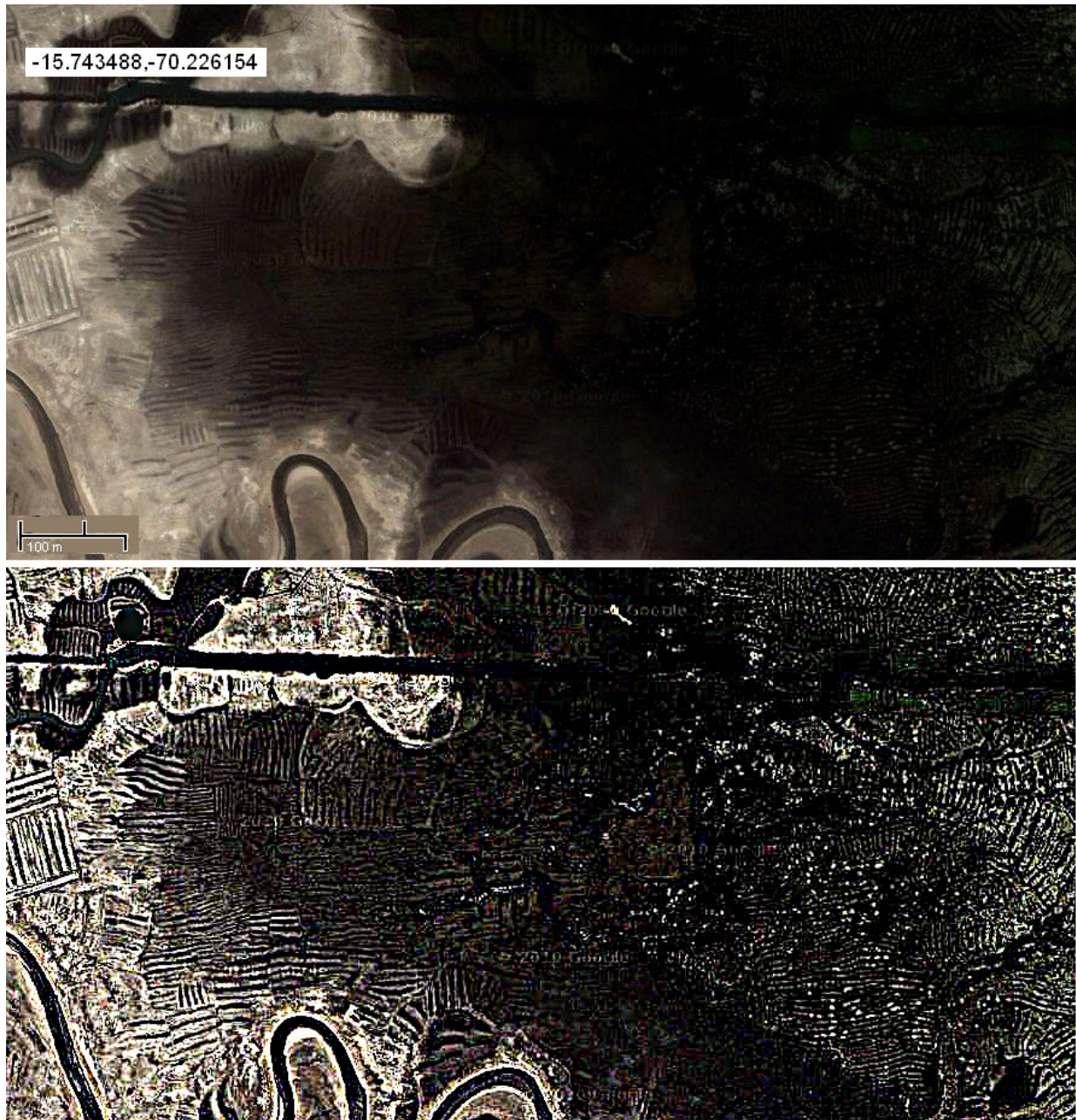
⁶Arqueólogos continúan identificando geoglifos del Titicaca, Con Nuestro Peru, 20 Oct 2010, http://connuestroperu.com/index.php?option=com_content&task=view&id=13315&Itemid=38; Gary Mariscal, Dirección Regional de Cultura de Puno, private communication. Dr. Mariscal sent to the author pictures of several locations reported in Ref.3: from the pictures it is possible to see the patterns created by the waru-waru. It seems to observe a huge maze on the ground.

In the following image, a lagoon of Machacmarca, near Sillustani. In the upper panel, the original image from Google, in the lower panel the image after filtering. Note that the processing is able to increase the visibility of the lagoon.





Another lagoon: note that the surface that is now covered by water, was previously used for cultivation by means of waru-warú. This means that the climatic conditions of the region changed.



This is a part of the Umayo Lagoon. Note that the filtering of the satellite image with wavelets (lower panel) reveals in the image that the lagoon was more dry in the past, being a land covered by the waru-warú earthworks. We see clearly the distribution of waru-warú in the lower panel of the figure.

In the following image, another part of the Umayo Lagoon. Again we see that under the water, the persistent traces of waru-warú.



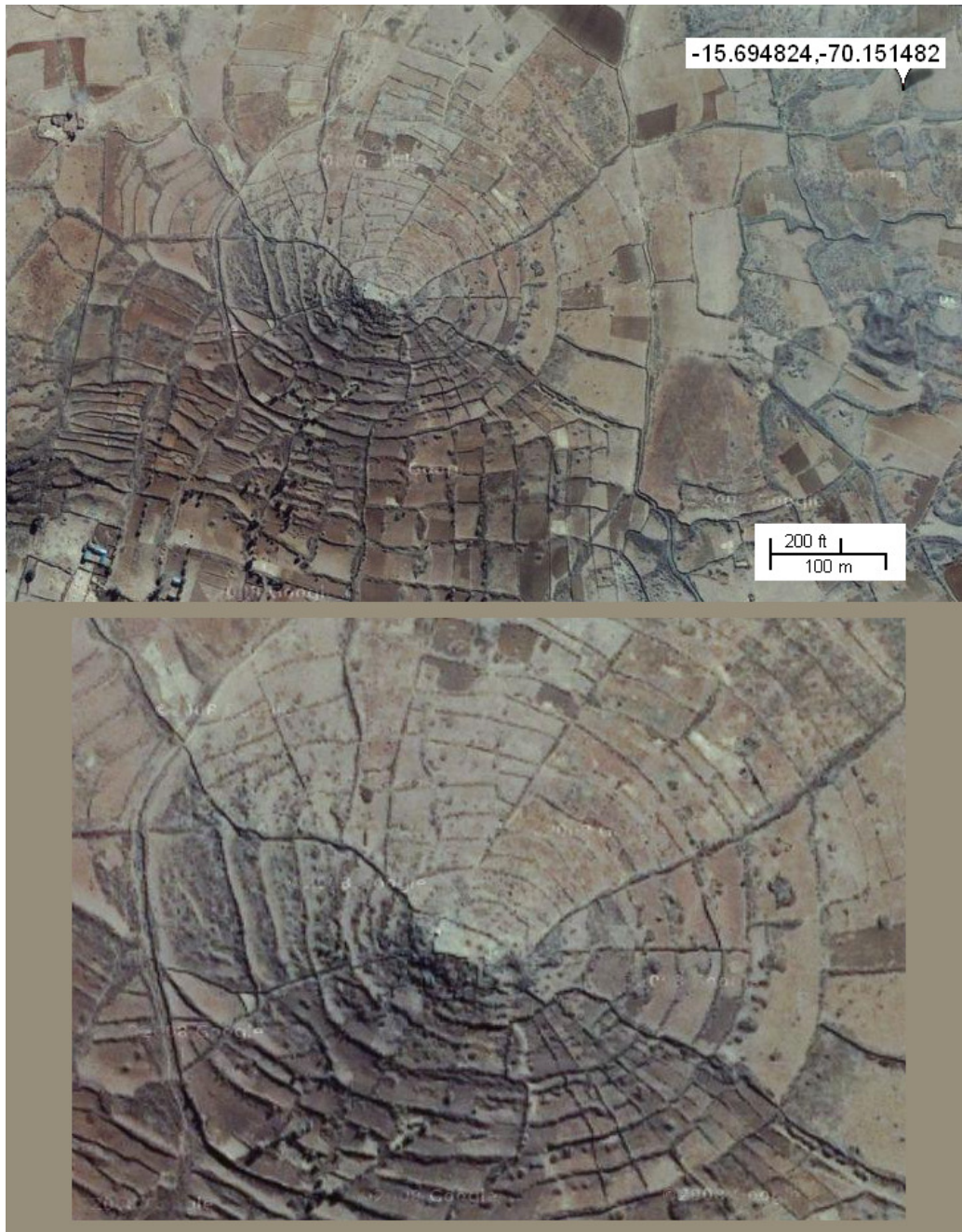
Other parts of the Umayo Lagoon.



Here two images of Atuncalla: a circular “village” and an area covered by earthworks.



Details of the earthworks of Atuncalla, after image processing with wavelet filtering.



Note the engineering ability of the people who built this structure. This is terraced hill of Atuncalla with an almost perfect bell-shape. Over the hill we see lines, that seems to joint points of equal level, as in cartography the contour lines. We see also lines that are perpendicular to them, that is lines following the gradient. Let us remember that in the vector calculus, the gradient of a scalar field is a vector field which points in the direction of the greatest rate of increase of the scalar field, and whose magnitude is the greatest rate of change. In the case of the figure, the scalar function is the height on the sea-level and the gradient is the highest slope direction. This means that people arranged the walls to have the highest effect in reducing the erosion of soil by atmospheric actions.

We have seen images from the space of waru-waru and terraced hills near Sillustani.

Since the terraced hills are in strong connection with the presence of waru-waru, we could argue that these engineered hills are also of a product of a pre-Incaic period (Peruvian archaeologists are considering waru-waru a product of Pukara people). In any case, the remains of this overall agricultural system are providing evidence of the impressive engineering abilities of the peoples who lived in Andean countries many centuries before Columbus arrived.

Let us remember that Lake Titicaca sits 3,811 m above sea level, in a basin high in the Andes on the border of Peru and Bolivia. The western part of the lake lies within the Puno Region of Peru, and the eastern side is located in the Bolivian La Paz Department. Both regions have the slopes of the hills criss-crossed with terrace walls and the plains covered with raised fields, with related artificial canals and ponds.

As shown by increasing the resolution of images, we see objects that seem to be heaps or piles of stones, placed almost in the middle of terraced fields. Are these objects chullpa? Similar objects can be observed on the terraced fields of the hills in the Bolivian region near the Titicaca Lake, as in the following figure.



This is a place in Bolivia⁷. From comparison with images of Sillustani, we could argue that the terraced hills could be sometimes burial or worship places. This means then a strong connection between living people and their ancestors. As previously told, the recent research addresses possible associations between burial places and cultural landscape.

In any case, Google Maps are of great help for archaeological and historical researches, in particular for Andean countries, where many locations seem to be well-preserved and not revolutionized by modern cultivation techniques. Public satellite maps service shows itself as a powerful tool for the analysis of the cultural and historical landscape.

⁷ Place was localized by authors of web page <http://www.atlantisbolivia.org/geoforms.htm>.