Terevaka Archaeological Outreach (TAO) 2022–2023 Field Report: Program Expansion

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Since 2003, Terevaka Archaeological Outreach (TAO) has offered unforgettable educational opportunities regarding archaeology, traditional lifeways, technology, and sustainable development at no cost for Rapa Nui high school students. After 20 years of refining our pedagogy and implementation, 2022–2023 marked a year of rapid expansion for TAO. Within a 10-month period, TAO completed two projects on Rapa Nui, and also launched sister programs in the Sacred Valley of Perú and in Patagonia National Park of Chile.

Keywords: Rapa Nui, fieldwork, archaeological conservation, cultural heritage

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Introduction

Since 2003, Terevaka Archaeological Outreach (TAO) has offered unforgettable educational opportunities regarding archaeology, traditional lifeways, technology, and sustainable development at no cost for Rapa Nui high school students. Since 2014, TAO has been incorporated as a US 501(c)(3) nonprofit organization, and our three-part mission remains constant: (1) education—to offer experiential learning opportunities specific to cultural and natural resources that surround the local community; (2) conservation—to promote awareness and expertise in conservation measures and sustainable development; and (3) research—to document and study both cultural and natural phenomena of the past and today.

The long-term success of TAO comes from our praxis in making conservation and research accessible to rural and Indigenous students through innovative educational programming. Our program's roots in anthropological archaeology ensure that our projects are not only culturally sensitive, but that they also develop practical solutions to local obstacles in a trajectory to a more sustainable future at the local level. Our solutions combine the best of traditional knowledge with modern technology.

After 20 years of refining our pedagogy and implementation, 2022–2023 marked a year of rapid expansion for TAO. Within a 10-month period, TAO completed two projects on Rapa Nui, and also launched sister programs in the Sacred Valley of Perú and in Patagonia National Park of Chile.

In sum, the expansion allowed us to work with 56 students and 12 interns, and to pursue 11 distinct long-term conservation/research initiatives.

Sacred Valley and Patagonia National Park

Building new TAO programs for the communities of Urquillos and Cochrane, in rural Perú and Chile, respectively, required new expertise, new logistics, and new technology. Specialized experiential curriculum was developed in the year prior to implementation, and in both locations Explora's hotel properties provided a critical, strategic base of operations. As with all TAO programs on Rapa Nui, the two-week intensive outreach efforts in the Sacred Valley (TAO-Qosqo) in July of 2022 and Patagonia National Park (TAO-Patagonia) in March of 2023 included campouts, class lectures, hiking, field and laboratory research, and lots of friendly competition (Figure 1).

Our principal conservation/research projects in TAO-Qosqo revolved around freshwater monitoring and archaeological conservation. On all hiking excursions, and around the local community of Urquillos, TAO students and staff collected test tubes of water from streams and rivers (including the Urubamba River). While collecting samples, students recorded specific GPS locations as well as apparent signs of human/livestock contamination. Subsequently, students tested water samples, using the SJ Wave 16-in-1 Water Test Kit, to derive metric estimates for:

- Total hardness: 0–425 ppm
- Free chlorine: 0–10 ppm
- Iron: 0–500 ppm
- Copper: 0–10 ppm
- Lead: 0–500 ppm
- Nitrate: 0–500 ppm
- Nitrite: 0–80 ppm

Figure 1. TAO-Qosqo students visiting the archaeological remains of the Pukara Alto site, southeast of Cusco.

- Potassium peroxymonosulfate: 0–20 ppm
- Total chlorine: 0–10 ppm
- Fluoride: 0–100 ppm
- Cyanuric acid: 0–250 ppm
- Chlorine dioxide: 0–500 ppm
- Quaternary ammonium compounds: 0–40 ppm
- Total alkalinity: 0–240 ppm
- Carbonate: 0–240 ppm
- pH: 6–9

Ultimately, the information collected by students was compiled to create an interactive web database to raise awareness within the Urquillos and nearby communities (Figure 2, https://terevaka.net/projx/vas/agua). In future iterations of TAO-Qosqo, we plan to repeat testing and expand our database geographically within the Sacred Valley.

TAO-Qosqo students were also introduced to three-dimensional orthocorrected photogrammetry on Explora hotel property—a technology used to stitch overlapping digital photographs together to generate a high-resolution digital model of a subject. The Explora Sacred Valley hotel property includes several Inca-era terrace walls, some original and some partially reconstructed. In order to provide the hotel, the local/Indigenous communities, and scientists with a digital replica of some of these terraces (and assure

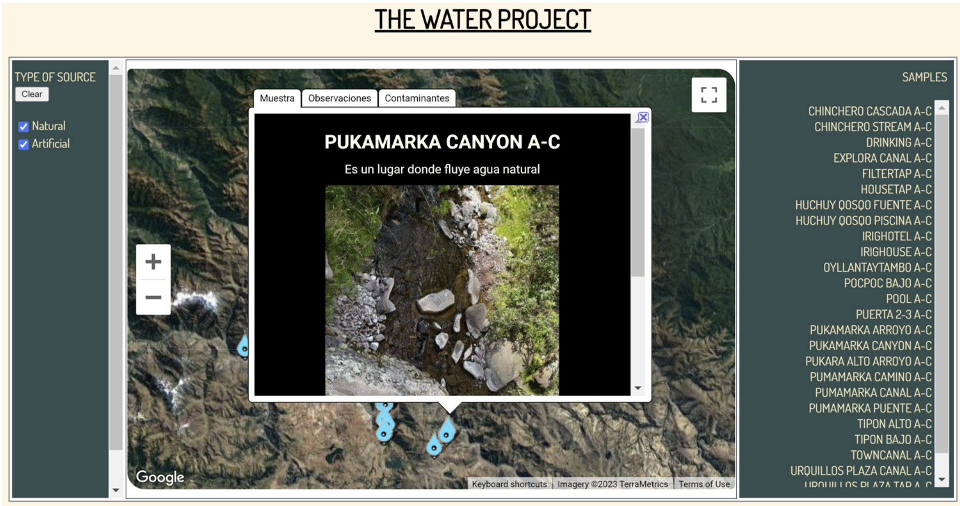

Figure 2. Screenshot of the interactive web database regarding local freshwater sources, assembled by TAO-Qosqo students and staff.

accurate repairs or reconstruction if damage occurs in the future), TAO-Qosqo students systematically photographed nearly 200m of terrace walls, using both a DJI Mini 3 drone for lower-resolution contextual images and a Canon EOS-6D DSLR body and Canon EF 24-105mm f/4L IS USM lens for high-resolution imagery of Inca stonework (Figure 3, https://sketchfab.com/terevaka). In all, the model includes details on upwards of 5000 carefully placed stones that cover some 450m^2 of area.

Figure 3. Screenshot of the three-dimensional digital model of an Inca terrace on Explora hotel property, created by TAO-Qosqo students, along with inset of details of stonework included in the high-resolution model.

In TAO-Patagonia, students focused on local flora and lichens. Each student collected plant samples on hikes and later returned to press and laminate the samples. Students also conducted research online and in guidebooks to include key information describing their laminated samples. By the end of the two-week program, each student went home with a personalized weatherproof field guide detailing 21 local plant species—fully equipped with a carabiner to attach to a backpack (Figure 4, https://terevaka.net/projx/pnp/flora).

TAO-Patagonia students also worked to assemble data to create a foundational geodatabase for long-term monitoring of lichen species, both in Patagonia National Park and closer to the nearby town of Cochrane. Dating back to at least 1866, lichens have been studied as proxies or bioindicators for air quality, pollution, and climate change (Nylander 1866, Conti 2008). Research of the lichen *Usnea barbata* has even been applied in areas of Argentinian Patagonia to study the atmospheric absorption of airborne elements (Conti et al. 2009). While TAO students did not conduct any chemical analyses, they did establish baseline data for location, context, size, and color of lichens to be used in a longitudinal study in and around Patagonia National Park (Figure 5, https://terevaka.net/projx/liquen).

Figure 4. Laminated field guides for flora local to Patagonia National Park, compiled by TAO-Patagonia students.

Figure 5. TAO students investigate a variety of lichen species growing in and around Patagonia National Park.

Rapa Nui

Two TAO-Rapa Nui programs were interspersed with the new implementations in the Sacred Valley and Patagonia, meaning that two separate classes of island high school students embarked upon their own research projects during December of 2022 and April of 2023. The two primary projects undertaken by TAO-Rapa Nui students were high-tech, noninvasive scanning projects of objects on the Museo Antropológico Padre Sebastián Englert property.

The first of these projects was an experimental application of ultrasonic scanning of *moai* (statue) fragments using the Pundit PD8050 handheld device created by Proceq. The project was led by guest expert, Pacific Island archaeologist Dr. Mark McCoy of Florida State University. The Pundit PD8050—an instrument more commonly employed commercially to inspect the quality of concrete—uses an eight-channel array in a fixed configuration to determine pulse velocity of materials and visualize internal structure in 2D and 3D. The device is advertised to locate subsurface defects of concrete, to measure thickness of concrete elements, and to determine concrete pulse velocity for homogeneity and strength estimation.

In the first-ever application of such technology to the statues on Rapa Nui, TAO students explored the potential in applying the Pundit PD8050 to volcanic tuff rather than concrete, and to learn more about the internal weathering and/or instability of the *moai*. In theory, this information could help us not only estimate the age of statue construction versus destruction, but also prioritize conservation/restoration efforts for statues on the island.

The Pundit PD8050's individual sensors are spring-loaded to allow for gentle contact with irregular surfaces (Figure 6). The software associated with the Pundit PD8050 uses artificial intelligence to detect the point at which the pulse leaves the material, known as back wall detection. This is important for calculating the pulse velocity of something with uneven thickness. Machine error is negligible. For example, for a target 1m in thickness, with a pulse velocity of 4000 m/s, the resolution is $\pm$1.6 m/s. Unlike other techniques, the handheld device is remarkably easy and fast to use and does not require any invasive/ destructive coring or sampling.

While the results of this first application of ultrasonic scanning remain preliminary, data produced by TAO students has demonstrated that the Pundit PD8050 can: (1) distinguish greater weathering on a statue's carved surface compared with its more recently exposed broken surface; and (2) visualize the weathering zone, previously observed by Orlando and Renzi (2013). These results are enough to warrant further investigation into this topic, and this pilot project has helped to secure additional research funding from both the National Science Foundation and Southern Methodist University. Subsequent fieldwork for the project will also be conducted through innovative TAO curricula, so that island high school students continue to take an active role in studying and caring for their material heritage.

Figure 6. TAO students carefully apply the Pundit PD8050 ultrasonic scanner to fragments of statue tuff outside the Museo Antropológico Padre Sebastián Englert's curation facilities.

Figure 7. Einscan SP desktop scanner with a *moai kava kava* (left) and digital model of a *tahonga* (right) created by TAO students.

Figure 8. 3D printed replicas created by TAO students to help create educational opportunities within the local museum.

The second scanning project that TAO students undertook used structured light technology with the 3D Einscan SP desktop scanner. The scanner projects a lattice of light across the object and then analyzes distortions in the pattern to assemble a dense cloud of points to estimate the object's surface and ultimately render the object digitally in three dimensions (Figure 7, https://sketchfab.com/terevaka). For years, TAO students have contributed to the 3D-scanning projects of the local museum's collections. The resulting scans have been printed and painted like the original objects to generate a replica collection for the Museo Antropológico Padre Sebastián Englert that is often used to create a tactile experience for younger museum visitors (Figure 8).

Conclusion

After 20 years of fruitful educational outreach on Rapa Nui, the TAO experience has expanded to reach additional rural/Indigenous communities in continental South America.

A more detailed account of our unique pedagogy can be found elsewhere (Shepardson 2021), but our program implementations are driven by the belief that conservation begins with building a passionate link between today's youth and the cultural and natural resources that surround their communities. We *must* directly involve students in all aspects of archaeological inquiry if we expect those students to assume responsibility for cultural heritage in the near future. The expansion of the program demonstrates the important role that Rapa Nui, with its rich cultural heritage, might play in setting examples for heritage management, education, and conservation around the world. The program's long-term success also offers an example of the mutual rewards when the scientific, nonprofit, and corporate worlds connect.

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