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15 Utilising Cultural Heritage to Improve Water Security and Agro-Pastoral Farming in the Peruvian Andes

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15.1 Introduction

Across the Peruvian Andes, the significance and value of high-altitude wetlands (lakes, peatlands, and wet meadows over 2500 m a.s.l.) and their associated water management infrastructure (e.g. micro-dams) should not be underestimated. For millennia, these have provided an essential contribution to a range of ecosystem services, especially as a source of water for cultivation and highly nutritious grazing land for animals, in addition to sequestering carbon, regulating water flow and enhancing biodiversity. Farming communities, and non-governmental organisations (NGOs) working with communities, recognise their importance and play an essential role in their management and conservation. Threats to wetlands due to climate change, including loss of glacier meltwater recharge, as well as drainage, conflict and mining, are well recognised. As such, these threats pose a considerable concern for water security and agro-pastoral farming.

In this study, we summarise past and present water management in the Peruvian Andes and then undertake two case studies of wetlands and their associated water management infrastructure located in central Peru (Figure 15.1). The first is Antaycocha (Chillón valley, Lima Region), where we demonstrate how palaeoecology can be used to inform about the timing and role of dam construction and associated socio-economic change during the last 3000 years. Our second study concerns Ricococha Alta (Cordillera Negra, Ancash Region) where we demonstrate the contribution of indigenous knowledge and community engagement in dam restoration for protecting cultural heritage and sustainable development in the context of climate change. These studies show how a blend of knowledge from cultural heritage, palaeoecology and indigenous communities can be used to better understand human–wetland interactions and provide know-how to inform approaches to sustainable rural development.

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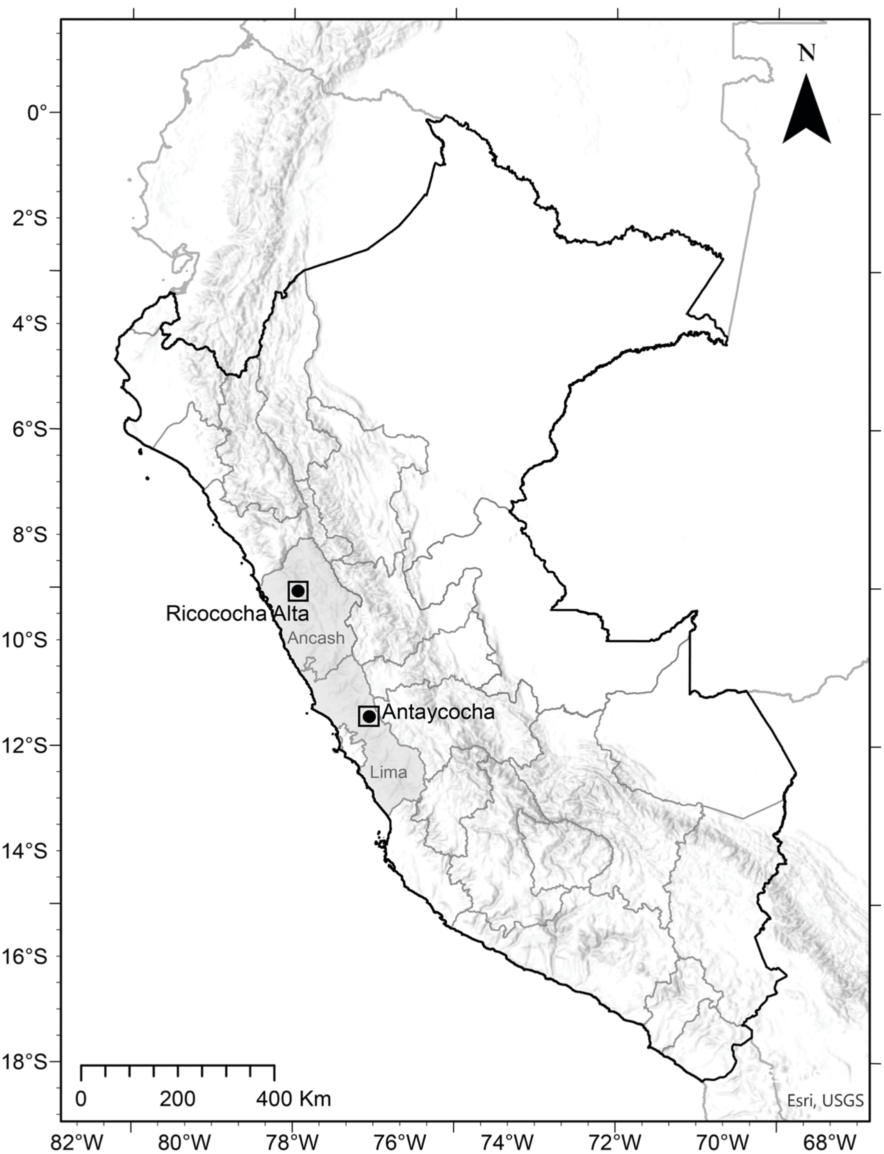

Figure 15.1 Location of Ricococha Alta (Ancash) and Antaycocha (Lima), Peru. © Josie Handley, www.gadm.org/

Note: Produced in ArcGIS Pro 3.2.0, using GADM (2018) administrative boundary data.

15.2 Water Management in the Peruvian Andes, Past and Present

In the 21st century, water scarcity is increasingly seen as the main threat to human world economies and the harbinger of future conflict (Gleick, 1993; Swain, 2015; Patel et al., 2022). In this regard, the Peruvian Andean highlands constitute one such crisis region where lack of water is understood by experts as the single most threatened natural resource in the face of climate change and ever-retreating tropical glaciers, a sentiment echoed by local governments, NGOs and especially rural communities (Stark et al., 2012). Yet the present-day water scarcity is not a new phenomenon.

Archaeological, palaeoenvironmental and palaeoclimatic evidence suggests that climate change and water insufficiency were recurrent issues throughout Andean prehistory. One such period of climate instability is connected to the late Middle Horizon through to the Late Horizon when the Medieval Climate Anomaly (MCA: AD ~900–1300) and subsequently the Little Ice Age (LIA: AD ~1325–-1880) impacted the region (e.g. Haug et al., 2001; Rein et al., 2005; Apaéstegui et al., 2014; Stansell et al., 2017; Lüning et al., 2019). During this time, especially the MCA, lower precipitation and higher temperatures in warmer seasons undoubtedly meant less water.

Against this backdrop, pre-Hispanic communities across the Andean highlands invested heavily in hydraulic technology, thereby guaranteeing local resilience (e.g. Grana et al., 2024; Percero-Oubiña et al., 2016; Lane, 2021; Vining and Williams, 2020; Salminci et al., 2014). Part of this Pacific-facing mountain range is the Cordillera Negra in the Ancash highlands, North-Central Peru. Here, community-led investment in drainage-wide, integrated agro-pastoralist hydraulic infrastructure, including dams, check dams, silt traps, terraces, reservoirs and canals increased substantially during the Middle Horizon (AD 600–1000) through to the early Spanish colonial period (AD 1536–1615; Lane 2009). Indeed, such was the investment in hydraulic technology and the concomitant increase in human population among the local Huaylas population (Espinoza Soriano, 2013) that we can perhaps understand their adaptation as a study in ecological anti-fragility (Equihua et al., 2020).

In the present day, water access and security is a perennial worldwide problem critically impacting Peru (Ministerio de Desarrollo Agrario y Riego, 2019). A local adaptation to the increasing water shortage in the Andean region is the construction of micro-dams using concrete and steel. As of 2015, 743 micro-dams had been built in the Andean area, substantially adding to water security in highland rural areas. Micro-dams control water and soil erosion, feed subterranean aquifers and provide for people's livelihoods. Approximately 75% of these are at high altitude and directly impact the water supplies of local rural populations and then feed downstream to coastal regions (Autoridad Nacional del Agua, 2015).

Modern micro-dam construction is seen to tackle climate change-induced water scarcity, and through it, rural land abandonment, crop failure, outward migration, and community cohesion breakdown. Most of these dams have been built in the past 40 years (Paredes-Beltran et al., 2021). At a local highland environment level, the construction of micro-dams and reservoirs is seen as an important mitigating factor against climate change and water insecurity (Llosa Larrabure, 2008), especially given accelerating glacier retreat (Proyecto Glaciares+, 2018).

In many cases, however, the use of modern materials is not a sustainable or optimal solution. Cement and steel dams are prone to damage during seismic events, and once damaged are impossible for local communities to repair, leading to a functional lifespan of only 50 years (Wieland, 2010). They are very expensive and time-consuming to build, requiring non-local materials and constructors secured through local authorities in a process open to corruption. Furthermore, modern dam construction in the Andes mimics ancient adaptations to the same problem. Therefore, many of these new dams are built over ancient structures irrevocably destroying them; most of the pre-Hispanic structures are over 500 years old and can help us understand how ancient populations adapted to past climate change. Over 95% of these structures are currently unregistered archaeologically. Given the increasing water stress in the Andes, the current rate of ancient dam loss and destruction is unprecedented. Moreover, these ancient dams constitute available *installed capacity,* which can be rehabilitated for modern use.

15.3 Palaeoecological Investigation of the Antaycocha Wetland, Chillón Valley, Lima

15.3.1 Site Location and Archaeology

Antaycocha wetland (18L W: 8734617.13/S: 32700.00 UTM (WGS84): 3601 m a.s.l.) is situated in the Chillón Valley near the village of Canta. The wetland has a pre-Hispanic stone micro-dam feature at one end (Figure 15.2) and is fed by the Rantao Stream at the other, a water course originating from a spring in the mountain above (Cerro Paraguay). Modifications have been made to the stream's channel above the wetland in the form of a series of stone steps to slow down the flow of water in times of heavy rain (Farfán, 2011).

The Cantamarca archaeological site is situated on the hill above Antaycocha and is one of the main Late Horizon Inca sites in the valley. Although its origins are older and are thought to date to the first Lima occupations in the Early Intermediate Period (AD 1–650), evidence to support continuous occupation prior to the Late Intermediate Period at the site is scarce (Farfán, 2011). Populations began to expand in the Late Intermediate Period with the development of high-elevation defensive settlements on ridgetops. During this time, there was limited social stratification; instead, multiple political units controlled small territories and sources of irrigation water, with evidence for sites expanding and developing over time with no formal planning. During the Late Horizon, there was evidence of significant state influence from the Inca, who exerted control over large portions of the valley probably to control water resources. Sites at higher elevations were closer to main water sources (e.g. lakes and glacial meltwater) and provided the Inca not only with control of water but also with cultivation in the lower valley's desert-like areas.

Figure 15.2. The pre-Hispanic stone micro-dam on the Rantao stream at Antaycocha. © Nicholas Branch.

15.3.2 The Palaeoecological Record

To understand the developmental history of the Antaycocha wetland, a 5.97 m deep sediment core was recovered from the basin (Figure 15.3). The radiocarbon dating of the sequence revealed the sediments had a basal age of ~1010 BC (2960 cal. BP), with sediments accumulating over nearly the last 3000 years. Surprisingly, most of the sequence dates to only the past 550 years, with sediments located at 5.5 m dating to AD 1410–1455 (540–495 cal. BP) (a late, Late Intermediate Period to Late Horizon date). Consequently, a large volume of sediment has accumulated in the wetland over a relatively short time.

Within the basal 50 cm of the sequence, which pertains to a period of 2500 years largely covering the Early Horizon (800–200 BC; 2750–1850 cal. BP) and the Early Intermediate Period (200 BC–AD 650; 1850–1300 cal. BP), the record consists of inorganic lake sediments. The paucity of sediment accumulation during this time was likely due to stream flow into the basin having a higher rate. Within the pollen record (Figure 15.3), there are some indicators of human activity during the Early Horizon and Early Intermediate Period (LPAZ1), including the presence of *Sporormiella*, a fungus that grows on herbivore dung. Its occurrence within the

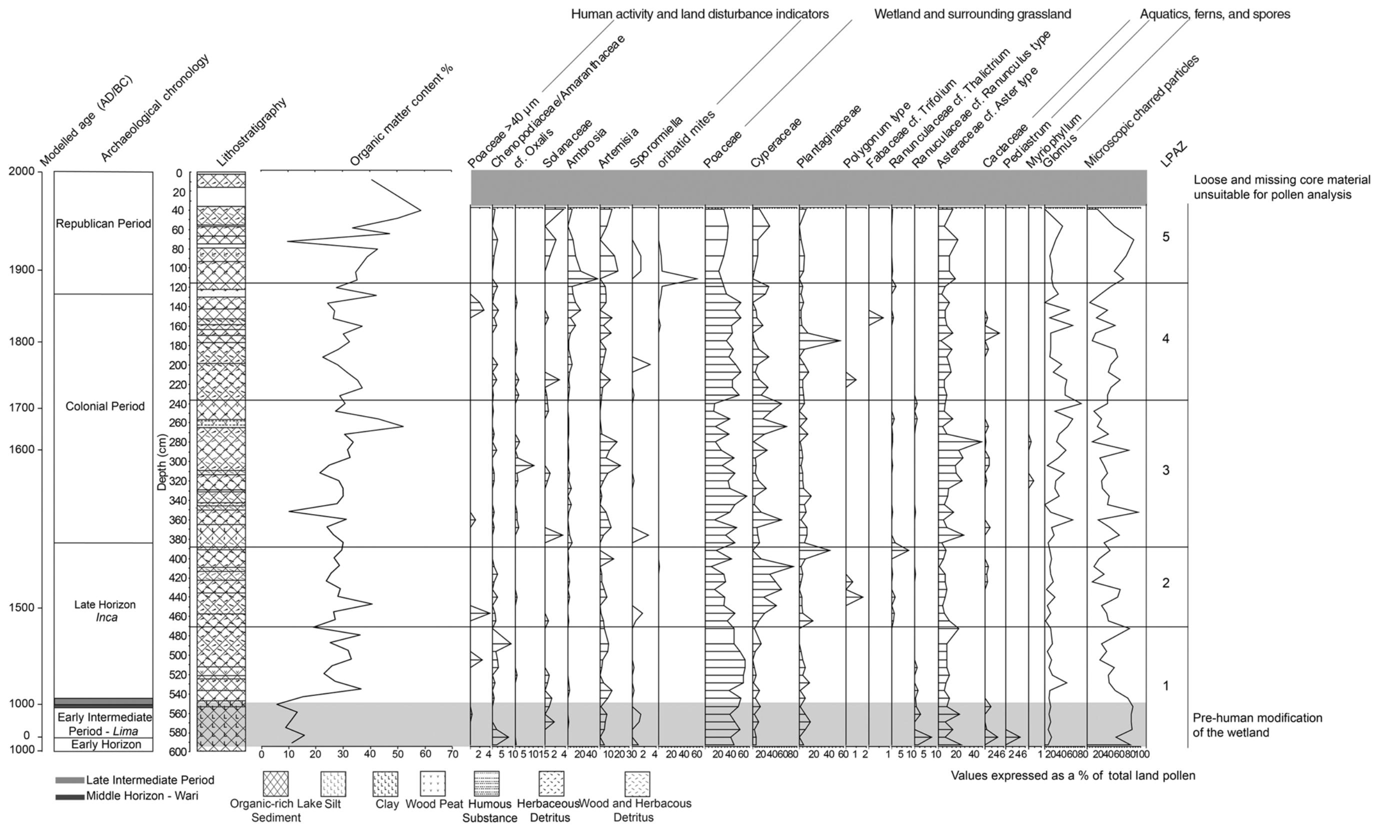

Figure 15.3 Antaycocha palaeoecological data together with the age-depth model and archaeological chronology.© Josie Handley.

Note: Diagram produced using TILIA and TILIA.GRAPH (Grimm, 1991).

Early Horizon and Early Intermediate Period probably reflects seasonal herbivore (camelid) use of the wetland for grazing and drinking water (see Chepstow-Lusty et al., 2019). Together with pollen evidence for Chenopodiaceae/Amaranthaceae and Solanaceae, it may indicate early agro-pastoral farming practices taking place around the wetland with both plant families containing important Andean crops, i.e. quinoa (*Chenopodium quinoa)* and potatoes *(Solanum tuberosum)*, respectively.

Following the Early Intermediate Period, there is a very short section of the record that correlates with the Middle Horizon (552–553 cm: AD ~751–979; ~1199–971 cal. BP). The reduction in sediment accumulation may have resulted from a lack of human activity and a consequent decline in landscape erosion within the basin catchment. This theory is supported by the absence of Wari-style ceramics at Cantamarca (Farfán, 2011), as well as a decrease in *Sporormiella* (Figure 15.3). Another possible explanation for the low sediment accumulation during the Middle Horizon could be a reduction in precipitation during the MCA (AD 900–1300; ~1050–650 cal. BP) causing less surface run-off from the surrounding slopes.

There is a renewed deposition of sediments from ~AD 1434 (~516 cal. BP), alongside an increase in organic lake sediments, which suggests a fall in the rate of water flow (Figure 15.3). The late, Late Intermediate Period/early Inca date coincides with the likely permanent occupation of Cantamarca. The marked change in lithology likely represents a period of modification of the basin, involving the construction of a stone micro-dam. The construction created a reservoir probably to increase water storage capacity mainly for agricultural practices. The timing of the reservoir construction coincided with a period of deteriorating climate during the Little Ice Age. This generally resulted in higher precipitation across the Peruvian Andes during the late, Late Intermediate Period and Late Horizon (Kanner et al., 2013; Apaéstegui et al., 2014). The construction of additional reservoirs recorded in the area may represent a response by the local populations to increased precipitation allowing for optimised water conservation practices (Farfán, 2011). Certainly, the construction of the reservoir at Antaycocha would have significantly increased the availability of water at a time when populations were growing in the valley.

Alongside the evidence for the construction of a micro-dam, there is also evidence for increased human activity at the transition to the Late Horizon (LPAZ1: AD ~1438; 512 cal. BP). Landscape disturbance becomes more apparent with soil erosion indicators, such as *Artemisia* and *Glomus*, alongside the presence of several crop types that may have been grown on the terraces. The presence of Poaceae >40 μm within LPAZ1 and LPAZ2 probably represents Late Horizon *Zea mays* cultivation, which may have been grown in association with quinoa, kañiwa and kiwicha, all pseudocereals in the Chenopodiaceae/Amaranthaceae family grown in the highlands both today and in pre-Hispanic types. The occurrence of *Oxalis* in LPAZ1 and LPAZ2 during the Late Horizon indicates that its tubers, known as oca, may also have formed an important dietary staple. In addition to crops, the presence of *Sporormiella* suggests that localised camelid husbandry also benefited from the increased water storage, probably using the reservoir for seasonal drinking water and grazing.

Following this, the transition to the Colonial Period (LPAZ3, AD 1532; 418 cal. BP) witnessed a reduction in the maintenance of the landscape. An increase in shrubland taxa (e.g. Asteraceae and Cactaceae) may signal their colonisation of the terraces and surrounding slopes. This is supported by a drop in Quinoa (*Chenopodium quinoa*) and Maize (*Zea mays*) cultivation during the first half of the Colonial Period (LPAZ3; Figure 15.3). Although there may have been a decline in cultivation, there is still a presence of animal husbandry, indicated by *Sporormiella* within LPAZ3 and 4. This likely represents a mixture of camelids and old-world domesticates such as cows and sheep, with the corrals around Antaycocha, most likely built in the Late Intermediate Period or Late Horizon, still in use today. With a fall in population levels, maintenance of the reservoir reduced and coupled with increased erosion led to the accumulation of a large amount of sediment over the past 500 years. The transition to the Republican Period at AD 1826 (124 cal. BP) recorded an increase in Oribatid mites, an indicator of herbivores in the landscape, alongside a later increase in *Sporormiella* at ~AD 1910 (~40 cal. BP; LPAZ5), providing clear evidence for herbivore activity around the wetland from the late 19th century onwards.

15.3.3 Interpretation

The timing of wetland formation at Antaycocha is of interest because the basal radiocarbon chronology indicates that sediment started to accumulate within small natural basins, sometime before ~1000 BC (~2955 cal. BP). However, once established, the wetland has evidence for human interference in its ecohydrological dynamics through the construction of micro-dams. This is dated to the Late Intermediate Period or early Late Horizon (Inca) date of AD ~1434 (~516 cal. BP) based on the radiocarbon chronology. The quality of engineering involved in the construction of the micro-dam suggests that the local community was knowledgeable and had expertise in the selection of suitable raw materials. Its construction at a time of an increasing usage of terrace agriculture is suggested by the archaeological record; such agriculture would have necessitated a dependable water supply for irrigation. The persistence of such agriculture in the landscape for over 500 years is testimony to the robustness of the micro-dam and the quality of its construction.

The archaeological evidence suggests that the timing of micro-dam construction coincided with possible agricultural expansion. This development, perhaps coupled with demographic change (e.g. migration), followed a prolonged period of lower precipitation during the MCA (AD ~900-1300; ~1050–650 cal. BP). The combination of a micro-dam, wetlands and ancillary technology (including canals, terraces and reservoirs) at Antaycocha and elsewhere in the central Andean Highlands strongly suggests that pre-Hispanic populations envisioned hydraulic management of whole watersheds integrating and feeding into agro-pastoralist economies (Lane, 2021).

Nowadays, the emphasis has changed. The Spanish colonial collapse of pre-Hispanic herding, which cemented itself in the 20th century (Flores Ochoa, 1980), has meant that in many areas of the Andes a whole way of life involving the intense rearing of domesticated camelids has practically disappeared. Against this backdrop, modern rural communities clamour for water from micro-dams which feed directly into a predominantly farming economy. This is the case of the Ricococha Alta restoration project, where the water thus gained will be used primarily for cash crop cultivation.

15.4 The Ricococha Alta Micro-Dam Restoration Project

The rehabilitation of a pre-Hispanic dam was the centrepiece of a pilot project: *Past Water Futures*. The dam in question is the Ricococha Alta dam located at 18L W: 8996716.00/S: 19304.00 UTM (WGS84) at an altitude of 4,560 m a.s.l. in the Pamparomas District, Huaylas Province, of the Ancash Region (Figures 15.1 and 15.4). This was likely first constructed in the late Middle Horizon (AD 750–1000), although there seems to have been considerable continued investment during the late, Late Intermediate and Inca Period (Lane, 2011).

15.4.1 Construction and Restoration

The dam is a double-walled construction oriented roughly east-west with a length of 45.7 m, an average width of 2 m and a maximum preserved height of 2.35 m. Both ends of this gravity dam are anchored onto the andesite bedrock. The inner and outer walls of the dam are made up of irregular stone blocks held together with a sandy clay mortar. The dam core – the infill between the walls – is composed of this same clay mixed with gravel. The dam presents a single sluice

Figure 15.4 The pre-restoration landscape of the micro-dam at Ricococha Alta. Past Water Futures Project.

at the base of the wall (17.4 m from the western end of the structure) measuring 0.36 m in height by 0.26 m in width. It is likely that a further sluice was present along the crest of the wall, but this had eroded away. The maximum surface of the basin is 12,320 m^2, with an estimated volume capacity of 30,000 m^3. The general state of preservation of the asset was good, especially given its lack of maintenance, presenting only some minor wall subsidence, crest erosion, and plant overgrowth.

The dam lies within the boundaries of the '*Los Vencedores de*' Cajabamba Alta community located downstream at an altitude of 3,687 m a.s.l. Work on the dam's restoration was undertaken in close coordination with the community during the 2022 dry season (April–October, especially between August–September 2022). The community fully supported the project, particularly given the earlier failure of the Ricococha Baja dam project, which had destroyed a partially functioning pre-Hispanic dam to build a modern cement micro-dam in 2008, this dam failed that same year.

In a departure from the use of cement and steel, our restoration project embraced the use of traditional materials and techniques combined with adaptable modern materials such as geotextile, geomembrane, and a mechanical sluice. Our approach to the dam restoration combined established wall conservation methods allied to local knowledge and modern technological advances. Rehabilitation of the dam went through several distinct phases (Figures 15.4–15.6):

1. Archaeological and geophysical survey of the dam including photogrammetry of structure.
2. Cleaning of extant structure of overgrowth.
3. Template trace survey of walls using plastic sheeting.
4. Photographic and drawn profile record of cleaned structure.
5. Codifying of all stone elements.
6. Removal of clay–gravel core and loose stones.
7. Placement of geomembrane (1.5 mm thickness) and geotextile (300 kg/m^2) in between inside and outside walls.
8. Recompositing of the dam core, using a compacted mixture of clay (2 parts), sand (1 part), earth (0.5 part), and gravel (0.5 part).
9. Conditioning of original sluice area to insert modern mechanical sluice mechanism.
10. Emplacing of loose stones and collapsed stones to achieve the original height of structure (Figure 15.5).
11. Final recompositing of crest core, stone crest and placement of top sluice at the level of dam crest (Figure 15.6).

The whole restoration process was recorded. Finally, it is important to note that in accordance with best-practice conservation protocols, reversibility was a key factor guiding the dam restoration. Therefore, it will be possible at a later time to remove all modern additions should a better solution be found in respect to their

Figure 15.5 Restoring fallen rocks manually onto the dam crest, Ricococha Alta. Past Water Futures Project.

Figure 15.6 Fully restored Ricococha Alta dam. Past Water Futures Project.

purported functions; this includes the geomembrane, geotextile, and mechanical sluice.

15.4.2 Engaging and Working with the 'Los Vencedores de' Cajabamba Alta Community

The Ricococha Alta dam restoration project with the '*Los Vencedores de' Cajabamba Alta* community had a long gestation period dating back to the early 21st century when part of this research group started working in the area (Herrera, 2005; Lane, 2006a). At the time, archaeological surveys and excavations centred on teasing out the mechanics of late pre-Hispanic (AD 1000–1532) polities in the region based around the social and economic underpinnings of agro-pastoralist communities (Lane, 2006b; 2007). Even then, the importance of water in conditioning the parameters of pre-Hispanic society was a salient issue. A key result of our research was the identification of numerous abandoned hydraulic management systems integrating soil and water conservation and usage across whole watersheds (Lane, 2009). In essence, *installed capacity* that could be reconditioned for use in the present day.

The easiest of these abandoned technologies to recover were the water dams given their increasing ubiquity as a quick, tried-and-tested modern response to water insecurity and scarcity in rural Peru (Autoridad Nacional del Agua, 2015). The need for additional water by rural communities in the area was made patently clear every time we visited the region. In this regard, the plight of the Cordillera Negra is particularly germane to hydraulic capacity building, given its drier environment in the past and its ever-increasing aridity in the present (Branch et al., 2023). Nevertheless, the shortcomings of many modern Central Andean micro-dams are equally plain to see. Of 13 dams in our study area, three of them were pre-Hispanic and were partially working, while the rest are modern (>30 years old), of which only one was continuing to function (Llosa Larrabure, 2008). Some like Ricococha Baja, the downslope twin to the recently restored Ricococha Alta dam, were catastrophic failures of planning, execution, and effectiveness. At Ricococha Baja, a new concrete micro-dam was built during 2008, effectively destroying its pre-Hispanic precursor. It lasted six months in operation, as cost-cutting and sub-standard materials, combined with indifferent engineering expertise, led to the dam leaking extensively during the first rainy season.

It was the failure of this modern dam, built with the *'Los Vencedores de'* Cajabamba Alta community's enthusiastic support and with what had been optimistically termed '*materiales noble*' (prestige material), such as cement and steel rods, that provided the local social conditions for the restoration of a pre-Hispanic dam. Given the modern dam fiasco, the *'Los Vencedores de'* Cajabamba Alta community was much more open to entertaining the possibility of rehabilitating an older dam, using lowly regarded *'materiales base*' (base materials), such as locally available rock, gravel, and clay, combined with a necessary upscaling of local construction knowledge, such as that used on traditional canals, to restore Ricococha Alta.

Restoration of the Ricococha Alta dam was coordinated closely with the village authorities and community members, taking a little over a month to complete. The work by the community was paid at a rate commensurate with a day's field labour. While restoration works were overseen by a team of trained restorers and archaeologists, the community provided the necessary construction know-how, including the location of suitable clay and gravel sources. The project foreman was also a community member with extensive experience in building stone and clay canals and walls. The placement of geomembrane, geotextile, and dam sluice was carried out under the guidance of the head restorer.

Throughout, local community buy-in on the project was crucial both for its execution and as a key component of ongoing maintenance of the dam. This last point is critical if the dam is to become an integral feature of the community. A series of guided workshops have helped instil in the community the need to adopt the structure within their yearly communal activities, for instance canal cleaning tasks which occur in April and October. Since the completion of the dam in October 2022, the dam has been regularly maintained and is working, having filled up three times during the 2022–2023 rainy season.

Still, one of the main challenges will be maintaining interest in the dam and its yearly maintenance by the community: times shift, community leaders change, and what seems relevant and important now might not be so in future. In the medium term, the research team will continue monitoring the dam and the extent of community engagement. We are nevertheless encouraged by the fact that since the successful restoration of Ricococha Alta other communities in the area have engaged with us towards restoring similar structures in their watersheds. To this end, we selected Weetacocha dam, belonging to the nearby community of Racratumanka as the next restoration candidate, with the work completed in 2024.

A further important challenge was finding the right grant with which to fund the Ricococha Alta project. Essentially, this had to wait for a recent significant shift in funding parameters, which now increasingly include climate change, social action, and heritage protection as essential considerations in their funding decisions. Alongside funding secured from the Gerda Henkel Foundation, the Harte Family Fund, and Rotary International, other bodies such as the World Monument Fund, the Mountain Institute – Peru, and McKnight Foundation have recently expressed interest in these types of rehabilitation projects demonstrating a shift from the preservation of sites towards site preservation coupled with measurable social impact.

15.4.3 Project Impacts

In the short term, the Ricococha Alta restoration project brought back into function a heritage dam with an estimated capacity of ~30,000 m^3. Since this restoration, the dam has been refilled three times, adding a further ~90,000 m^3 of water to the directly impacted 200 families from two adjacent communities (Cajabamba Alta and Putaca), while indirectly contributing water to a further 250 households downslope including Cajabamba Baja, among others. In total, this represents over 1200 people. This success has been instrumental in the community's adoption of the dam and its incorporation and continued maintenance during the twice-yearly chore of canal cleaning undertaken by the inhabitants of Cajabamba Alta.

The water produced by the Ricococha Alta dam is used primarily for downslope farming of subsistence crops such as maize and potatoes, but more importantly of cash crops such as peas (*Pisum sativum*) and further downstream avocado (*Persea americana*). Furthermore, the community of Cajabamba Alta will also use the extra water to grow alfalfa (*Medicago sativa*) as cattle fodder. The community maintains alfalfa-fed milk cows for their artisanal cheese factory; the cheese thus produced is sold in the nearby Caraz market. The milking of cows for cheese production is a key activity for women within the community, with the proceeds directly benefiting networks of female community members. There were at least two unintended proximate consequences of the dam restoration: firstly, an increase in bird numbers at and around the lake as they flock to this 'new' source of water; secondly, the emergence of new springheads downslope from the dam, as the newly filled dam basin replenishes underground geologic water aquifers.

In the medium to long term, the *Past Water Futures* project has provided a critical proof-of-concept pre-Hispanic dam restoration. Premised on the understanding that worsening climate conditions will negatively impact water sustainability and community resilience in the Andes, the successful restoration of an *installed capacity* asset such as the Ricococha Alta dam provides a community-led, low-carbon, low-cost, and low-maintenance alternative to modern cement micro-dams and water scarcity in the region.

The upscaling of this solution has enormous potential, with hundreds of ancient dams across the Central Andes available for rehabilitation. Such scaling relies on existing examples, such as the Ricococha Alta dam, that ably demonstrate to local communities the effectiveness of *installed capacity* restoration. In this regard, community buy-in for such projects is essential. Without the support from community members, the possibility of successfully restoring pre-Hispanic dams is compromised. Community participation is critical across the survey, building, and monitoring stages of the dam restoration. Only by making the dam theirs is success better guaranteed.

15.5 Reflections

The two case studies presented here amply demonstrate the forward thinking and long-term investment by rural pre-Hispanic communities in the face of past climate variability and socio-economic change. At present, given the widely recognised impact of the climate emergency in the Peruvian Andes, including debilitating economic and social effects of increased water shortage, land abandonment, drought, and crop failure, we believe that the deployment of cultural heritage data, and the utilisation of indigenous knowledge and expertise, could improve water security and ensure the sustainability of rural farming practices in the future.

Local and national government institutes, and NGOs, are aware of the growing problems and have, since the mid-1990s, undertaken development programmes aimed at counteracting the effects of water scarcity. Primarily, the solution has been to build concrete micro-dams along headwaters of valleys, i.e., across the front of existing wetlands. Essentially, this mirrors the pre-Hispanic adaptations we have recorded in these two case studies. Indeed, in many examples, the new dam has been placed on top of a pre-Hispanic structure. However, modern concrete micro-dams have significant weaknesses: they are expensive, rely on non-local expertise, and have a functional lifespan of only 50 years.

By contrast, ancient micro-dams were the product of millennia-long engineering projects that integrated these technologies with the immediate landscape and ensured wetland management from the top of watersheds downwards to agricultural fields. They were based on local knowledge of raw materials and would undoubtedly have been easily maintained. Furthermore, our Ricococha Alta restoration case study demonstrates that in these regions, where the poverty rate is high, the restoration of ancient micro-dams can rehabilitate the wetland ecosystem and benefit local farming communities. Indeed, having clearly demonstrated the benefits of micro-dam construction at Antaycocha for pre-Hispanic agro-pastoralists living in the Chillón Valley, it seems sensible that future restoration work should also be conducted in other parts of the Peruvian Andes, which will have considerable benefits for local communities across the wider geographical area.

The restoration project was rooted in a respect for communities and local knowledge, allied to flexible modern engineering. We contend that modern engineering can only provide partial solutions to improving water security in the Peruvian Andes and that the marriage between past and present knowledge and technology delivers a better, locally informed answer to future water stress due to climate change. Given that ancient micro-dams are common to the Andean highlands, our success on this rural development project we believe provides a cheap, easily applicable, community-based solution to water scarcity across large areas of the Andes.

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