PACC INFO brief

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Programa de Adaptación al Cambio Climático

PACC InfoBriefs provide systematized information based on PACC's experience and contribute to climate change adaptation management in mountain ecosystems.

Securing water in high Andean watersheds in Southern Peru: an ancient technology for securing water under climate change conditions

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BACKGROUND

The alarming reduction of water sources in high Andean areas is related to two main drivers: human pressure on ecosystems and climate change effects. On one hand, overgrazing, the expansion of croplands, forest and pasturelands fires affect land stability, leaving them exposed and vulnerable to climate conditions. On the other hand, climate phenomena such as winds and precipitation affect these vulnerable soils more easily, thus accelerating erosion and desertification processes. Under a climate change context, it is foreseen that these problems will be intensified. In this sense, both factors induce ecosystems to a gradual and permanent detrimental process, the consequences of which affect water regulation capacity and therefore water availability, mainly for rural families and communities highly dependent on these natural resources.

1 Climate Change Adaptation Programme - PACC Peru.

Key concepts:

- Water securing systems are an integral proposal to adapt to climate change and they are rooted in local traditional knowledge.
- The appearance of water sources and water flow increase based on groundwater recharge and water harvesting allow for facing droughts in rural Andean areas.
- Water securing systems are mechanisms that improve hydrologic environmental services as well as the socio-cultural relationships of the rural population.
- Storing 1m^3 of water using water-securing systems based on ancient technology may only cost US$ 1.00, while storing water in a reservoir made from concrete may cost US$ 48.00.

To strengthen water security in high Andean areas, there is a need to promote measures and/or technologies that have proven their low cost efficiency, replicability and capacity to deliver direct benefits to rural families. In this sense, this InfoBrief highlights the advantages of the so called 'water securing systems' that have been promoted by the Climate Change Adaptation Programme (PACC Peru) in the Cusco and Apurimac regions, southern Peru.

These systems comprise the construction of rustic micro-reservoirs (qochas), and the integral management of the pasture where groundwater is recharged. These jointly contribute to the improvement of water provision, recovery of environmental services and strengthen the productive activities of the rural population. These actions, which are grounded in the ancestral knowledge, have been strengthened with the current technical knowledge, and thus have proved a powerful tool that allows for climate change adaptation.

Rustic reservoirs (Qochas) made by rural families and installed in the micro-watershed Mollebamba, Apurimac region.

In this sense, there is a need to strengthen water management, and mainly water availability. This implies emphasizing the role of the headwaters and the ecosystems of the Puna, which play a key role in terms of water security.

SOUTH ANDEAN CONTEXT UNDER CLIMATE CHANGE

Climate Change impacts are increasingly evident and intense. Studies on climate behaviour in the south of Peru, mainly in Cusco and Apurimac regions, demonstrate that in the last 40 years, the climate has been changing (SENAMHI 2011). Similarly, climate change scenarios by 2030 show that maximum temperature will increase in maximum 1.6 °C, and that precipitation will be reduced in maximum -42% in some seasons of the year. In fact, this is quite an alarming outlook, since average fluctuations are 15% above and/or below the mean. As a consequence, water reservoirs, such as glaciers, are expected to be lost, while droughts and frosts are expected to be accentuated, as well as landslides and floods.

On the other hand, anthropic pressure on the Andean ecosystem will continue to be one of the main underlying causes for environmental impacts in these mountain regions. Activities such as cattle raising intensification, cropland extension, forest fires and the loss of native forests, drive the ecosystems to a gradual and permanent detrimental process (Buytaert et al. 2006; ERFCC Apurímac 2012), which in turn accelerates the erosion and desertification process. In fact, soil vulnerability is alarmingly increased if it is considered that almost one third of the Peruvian high Andes is under desertification (3.01%: 3,862,786 hectares) or in any stage of this process (23.75%: 30,522,010 million hectares). This area is equal to the area covered by the regions of Ucayali, Madre de Dios, Puno and Piura, where 33.38% of the country's population is located (MINAM 2011).

In this context, the inadequate use of the lands, in addition to the climate change effects, impose a combined pressure on mountain ecosystems and their related environmental services; the consequences of which are shown in the reduction of water availability, which in turn affects the livelihood assets of the population directly dependant on water and climate conditions (SENAMHI 2012a, SENAMHI 2012b, Flores et al. 2012).

Farmers in Huacrahuacho micro-watershed (Cusco) building a dyke of the water reservoir.

RESULTS

CAPACITY OF WATER STORAGE SYSTEMS FOR SECURING WATER IN HIGH ANDEAN WATERSHEDS

In ancient Peru, technologies such as rustic reservoirs were implemented with the aim of storing water for dry months. There is still some evidence of these practices in some areas such as Champaqocha and Qocha qarkay in Andahuaylas, Apurimac region; the qochas in the valley Chicha-Soras between the Ayacucho and Apurimac regions; Qochapata in the valley of Colca, Arequipa region, among others. The rituality expressed in the celebration for groundwater recharge and water harvesting, have always been an expression of respect and appreciation towards a key resource for the Andean settler: Water. In this sense, the protection of springs and wetlands, the establishment of new vegetation species that capture water in "puquiales" and springs, and the upholding of the importance of all the system were part of the ancestral traditions.

Based on local knowledge, diverse initiatives and projects have fostered the recovery and promotion of technologies for traditional water storage in different parts of the Peruvian Andes. Based on PACC's experience, the promotion and widespread increase of this practice, has allowed the incorporation of the protection of recharging fields and the implementation of complementary actions such as infiltration trench, reseeding of natural pastures, gully control and reforestation with native species. In this context, a new proposal has been generated, called "*water securing system*".

Micro-reservoirs are small reservoirs or artificial lakes built in natural land depressions or on a natural lake, using local materials such as stones and land cloths (champas), with the aim of storing and/or infiltrating rainwater to the aquifers in areas of water stress. Their benefits can be observed in the recovery of downstream springs, and in the fact that they allow for the maintenance of moisture from natural pasturelands, and to access to water during scarcity periods (June, July, August), while guaranteeing crops and breeding.

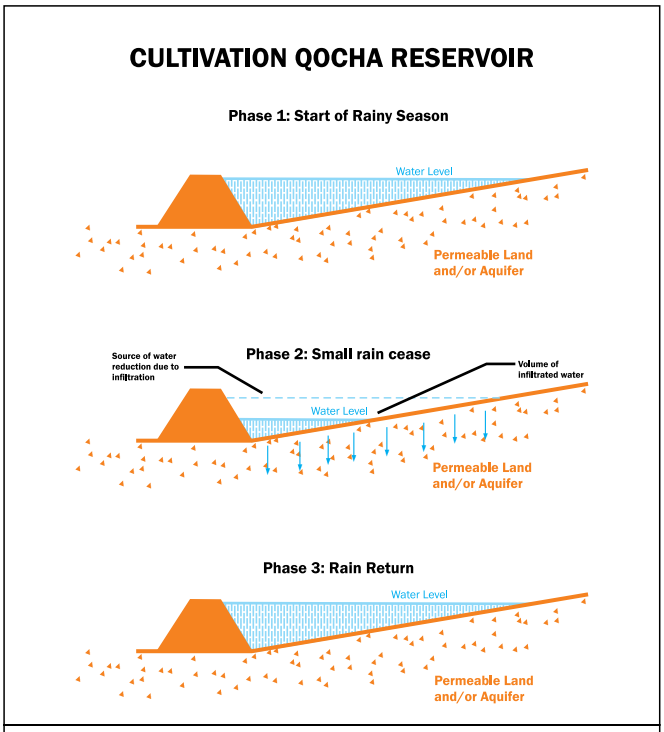
Rustic water reservoir in the community of Santa Rosa, micro-watershed of Mollebamba, Apurimac.

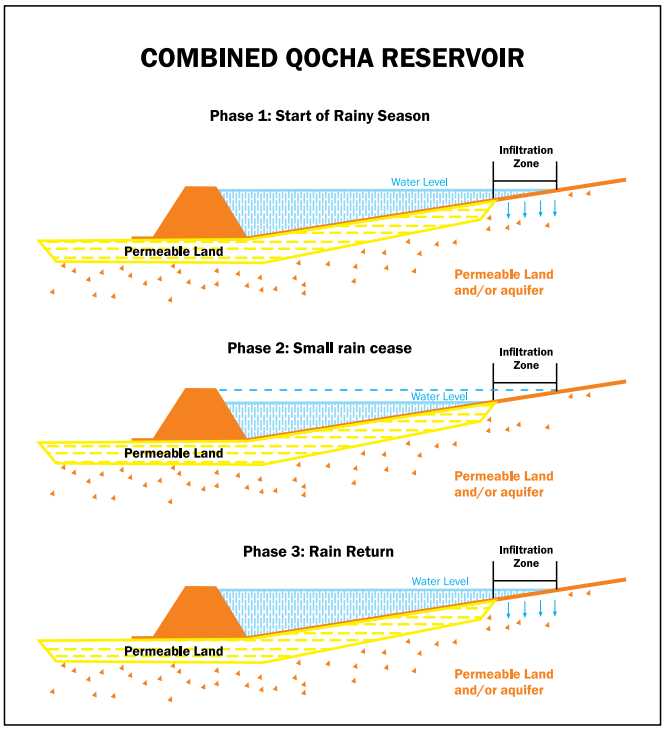
PACC INFO brief

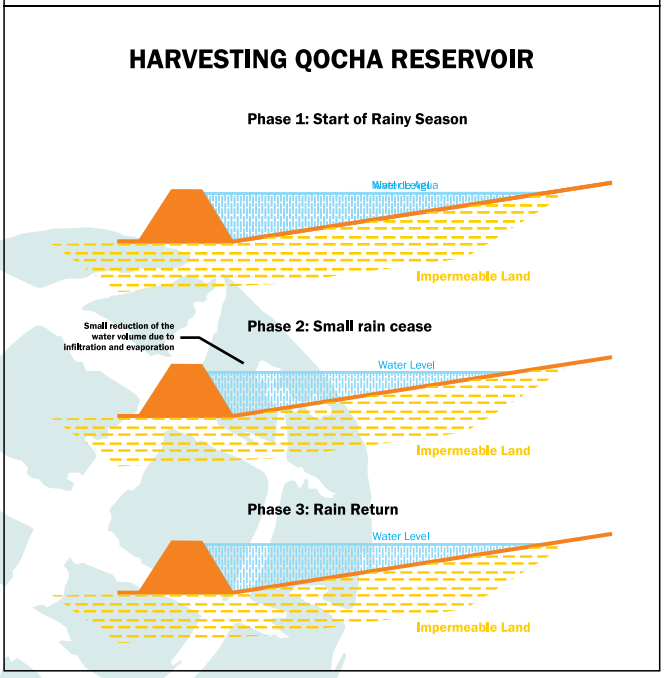
RESULTS

Preliminary studies on the behaviour of water securing systems (hydrogeology) in the upper parts of the Cusco region have led to the identification of three different system types (Pumayalli 2012):

- Micro-reservoirs for groundwater recharge, which allow water infiltration to the aquifer easily.
- Micro-reservoirs for "storage", where infiltration is harder, thus water remains retained for a longer period of time.
- "Multiple function micro-reservoirs"- those whose lower part of the watershed has permeable and impermeable sections.







Studies of IPEN (2014) and Pumayalli et al. (2012) indicate that most of these micro-watersheds contribute to the recharge of underground water and springs. In this sense, this behaviour, connected to an integral management and conservation of the recharge area, generate a mixture of benefits that may be translated into more water available for families and the ecosystem.

1. Water securing systems for ensuring water provision to families

One of the most important benefits of water securing systems is to increase water provision. On one hand, the rustic micro-watershed, which needs to be installed in natural dips, thus avoiding shifts in the environment and the lower part of the reservoir, allows for water storage and infiltration; while the protected fields favours

the development of vegetation cover, biomass and biodiversity. As a consequence, run-off is reduced and soil stability is strengthened, favouring water infiltration.

So, almost natural conditions are generated, allowing the improvement of water functioning of High-Andean ecosystems in terms of: (a) intercept and infiltrate rainwater for aquifer recharge; b) improvement of water regulation (capacity to distribute water in dry months); c) improvement in water yield (more water volume), and d) improved resource quality.

Based on PACC's experience, water-securing systems are developed in the micro-watersheds of Huacrahuacho in Cusco and Mollebamba in Apurímac regions in 2012 and 2013. During this time period, 146 rustic micro-reservoirs (qochas) were implemented, with an estimated capacity of 83,177m^3, with an investment of US$ 85 000.

In PACC's intervention areas, it has been observed that these water-securing systems have allowed, apart from storage, for springs recovery and for water sources; which has not been observed in areas where these systems were not implemented. Therefore, having more water availability has provided rural families with the opportunity to have access to water for direct consumption, divert water for pasture and field irrigation, improve their economic activities and in general, strengthen their livelihoods.

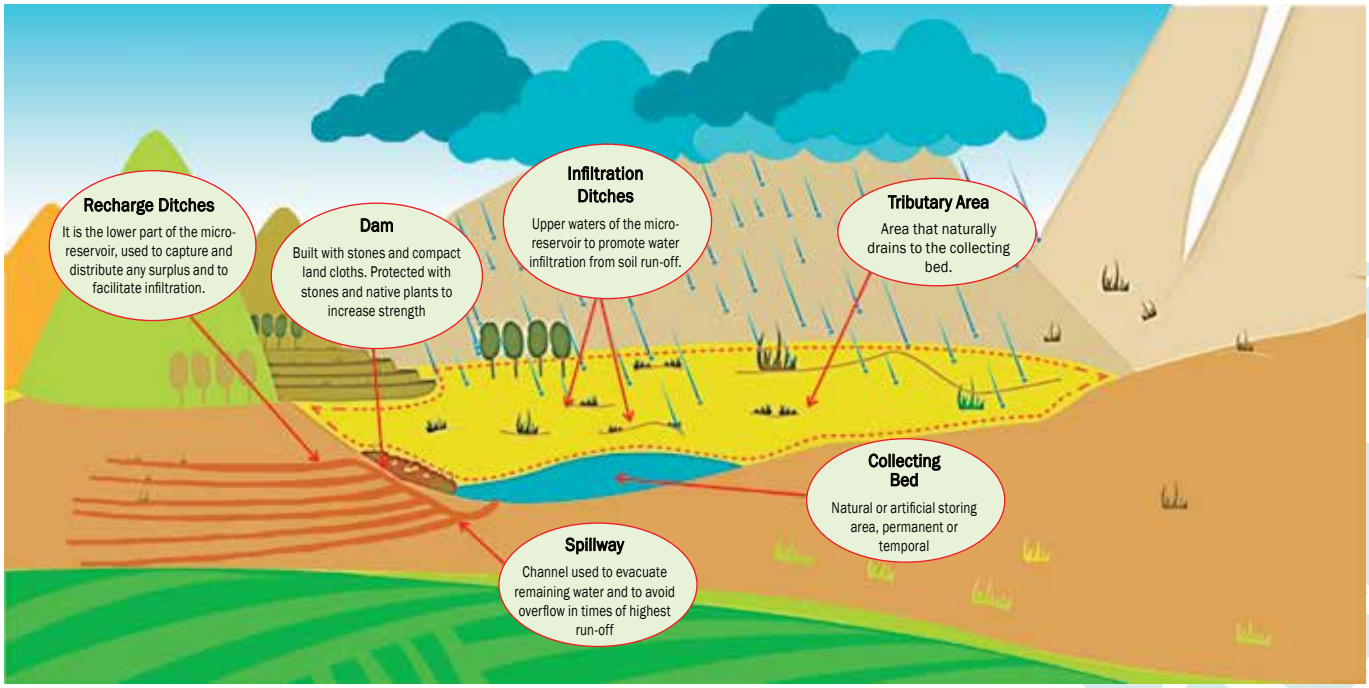
Even though the micro-reservoirs have two main functions: store and infiltrate water; it is important to highlight the importance of the latter: Infiltration. According to field observations and the testimony of the families and studies of Pumayalli (2012); a variety of springs and water sources may appear to recover their flow below the installed reservoirs, which is an indicator of the contribution of local aquifers. In this way, the contribution of underground water stocks would be significantly higher to what could be stored superficially (aboveground).

Nevertheless, the maximum volume to be infiltrated with these systems is still unknown, which will depend on the reservoir size, the field management, the impermeability of the lower part of the watershed and soil characteristics, among others.

2. Water-securing systems and the recovery of environmental services

Along with the improvement of water availability, based on water-securing systems, not only household activities are favoured, but there is also a contribution to the

Water-securing system model proposed by the PACC Programme



recovery of key environmental and social values, such as biodiversity, landscape beauty, climate regulation and socio-cultural ties.

In terms of biodiversity and landscape, the recovery of pastures and other vegetation species upstream and downstream of the reservoir has been observed. In addition, micro-flora and micro-fauna seem to have recovered and appeared, such as insects, pollinators, bird species (wild ducks, "guallata" birds, etc.), all of them using the new established lakes. In this sense, water, biodiversity and field are linked to the productive systems to improve landscape beauty.

On the other hand, it is possible to identify the enhancement of social assets. The efforts demanded by the construction of these micro-watersheds, and the protection of the fields, require the support of families and the community. These actions contribute to strengthen community work (ayni, minka), and to the social cohesion of the communities. Moreover, promoting an ancient practice constitutes a revaluation of the traditional knowledge and strengthens the living culture of groundwater recharge and harvesting. Complementarily, a reduction in household and community conflicts has also been observed, which typically result due to a more scarce resource with increasing demand.

3. The economic advantages of the rustic micro-watersheds

From the economic perspective, water-securing systems may be significantly cheaper than traditional reservoirs and reservoirs typically implemented with public investment. For instance, building one reservoir using concrete with a capacity of 1,000m^3, complementary works, training activities to irrigation users and organizations, may cost approximately US$ 110 000 – US$ 140 000 (MEF 2014). In the same line, one reservoir with similar characteristics to the one mentioned but with a storing capacity of 7,000 m^3 may exceed US$ 350 000 (1 million Nuevos Soles). In addition, land reservoirs, with art pieces and with a storing capacity of 50,000 m^3 may need an investment of more than half a million soles (US$ 170 000).

These costs, if compared to the investment made by the PACC Programme, with the support of the families and communities (US$ 85 000 in 146 rustic micro-watersheds and with an estimated capacity of 83,177m^3), shows that storing 1m^3 of water using water-securing systems may only cost US$ 1.00, while storing water in a reservoir made from concrete and in a land reservoir, may cost US$ 48.00 and US$ 3.5 respectively (Table N° 1).

Within the framework of PACC, the investment in water-securing systems was divided in the following way: families and communities provided workforce and tools, and the PACC Programme provided technical support (1 professional and 1 technician per watershed), economic incentives (prices) and some materials; which represent 68% and 32% respectively, amount equal to approx. US$ 85 000.

Table N°1:
Comparing the costs of storing 1m^3 of water per structure type.

Investment in qochas	Volume m^3	Investment (US$)	Cost per m^3 (US$)
Qochas and water-storing systems	83,177	85 000	1.00
Reservoirs made of concrete	7,000	340 000	48.00
Land reservoir	50,000	170 000	3.5

CONCLUSIONS AND RECOMMENDATIONS

Water is one of the key resources for sustaining life and social development. For the rural Andean population, a reduction in this vital resource may affect their fundamental life systems and therefore accentuate poverty. In this sense, water management, with an emphasis on water availability in watershed headwaters should be prioritized; especially when there is a constant threat of climate change, where future scenarios indicate the disappearance of important water reservoirs (glaciers) and an increase in droughts.

For adapting and coping with these new conditions, water-securing systems and/or the construction of rustic reservoirs, rooted in traditional knowledge, have demonstrated to be efficient mechanisms for the improvement of water availability in hydrologic, ecologic and economic terms. Therefore, it is an efficient measure for climate change adaptation as it allows for risk reduction of droughts, erosion and desertification. However, these measures need to be strengthened based on current scientific and technical knowledge in order to count on more efficient tools to strengthen development and climate change adaptation.

The advantage of the rustic micro-reservoirs “qochas” relies on the fact that it allows for water storage in dry months, but also for infiltrating to the aquifers (water reservoirs), which in turn increase underground water stocks. This second feature is perhaps one of their great advantages, but it is not quantified within the gained benefits: the hydrologic contribution and the amelioration of mountain ecosystem stability. However, there is a need to keep studying their real contribution to underground water.

Due to the low investment costs as well as to the ecologic and hydrologic advantages of the water-securing systems, public investment should revisit its water projects. This implies not only the construction of reservoirs and traditional reservoirs. Although the contribution of the micro-watersheds is at small scale, its massive implementation would mean a significant contribution to the watershed. In this sense, several families, mainly rural, will strengthen their productive activities, their livelihoods and contribute to water regulation from watershed headwaters.

Water-securing systems, by themselves, will not solve the water related problems in the rural areas or in the watersheds. These measures may be part and/or complement of a mechanism for the integral management of water resources, which considers hydraulic infrastructure, use efficiency, organizational strengthening, technology, among others.

Even though there has been a clearer approach in trying to describe the benefits of the water-securing systems based on several technical, scientific studies as well as on field observations and local testimonies, there is a need to keep improving an understanding of their advantages and limitations. For this purpose, researchers and the Academy need to take the lead and to deliver the needed knowledge to decision-makers.

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