The ADAPTS programme in Peru

Synthesis report

AEDES

PERÚ Ministerio del Ambiente

IVM Institute for Environmental Studies

Both ENDS
Environment and Development Service

Acacia Water
Solutions in Groundwater

Tomas Quispe[a], Karen Kraft[a], Anouk Franck [b], Lieselotte Tolk[c], Ralph Lasage[d]

(a) = AEDES
(b) = Both ENDS
(c) = Acacia Water
(d) = IVM

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For more information please visit our website: www.adapts.nl or contact ralph.lasage@ivm.vu.nl

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1. INTRODUCTION

1.1 ADAPTS in general

Climate change is not only expected to result in gradual changes in temperature, rainfall patterns and sea level rise, but also to increased climate variability and extreme events which will threaten water availability and food security for millions of poor people. Local communities and national governments both urgently need adaptation strategies to deal with these impacts.

In 2008, the Institute for Environmental Studies, ACACIA Water, and Both ENDS started the ADAPTS project, funded by the Dutch Ministry of Foreign Affairs. The overall aim of ADAPTS was to increase developing countries' adaptive capacities by including considerations about climate change and options for adaptation within water policies, local planning and investment decisions.

ADAPTS has worked with local communities, civil society organisations, local and national governments, scientific institutes and the private sector. It has shown that adaption is already taking place at the local level. ADAPTS sought to combine local and global knowledge in water management and to empower vulnerable communities to design and implement cost-effective and sustainable adaptation measures. Through dialogues with local and national governments it sought to ensure the inclusion of the knowledge and visions of local people in the development of climate-proof water policies and investments.

To increase adaptive capacities in developing countries, ADAPTS focused on:
1. **Knowledge development:** developing information about climate change and studying how local water management can be made climate proof.
2. **Local action:** the identification, support, documentation, analysis and dissemination of innovative, locally-based interventions to ensure that local knowledge and visions are included within dialogues about basin-level and national policy.
3. **Dialogue:** establishing policy dialogues between local and national stakeholders on the issues of sustainable water management and adaptation to climate change to ensure up-scaling and outreach.

The project took place in six countries between November 2007 and December 2011. This report summarises the main activities, results and insights of the Peru case. Similar reports for Ethiopia, Ghana and Vietnam can be found at www.adapts.nl.

1.2 ADAPTS in Peru

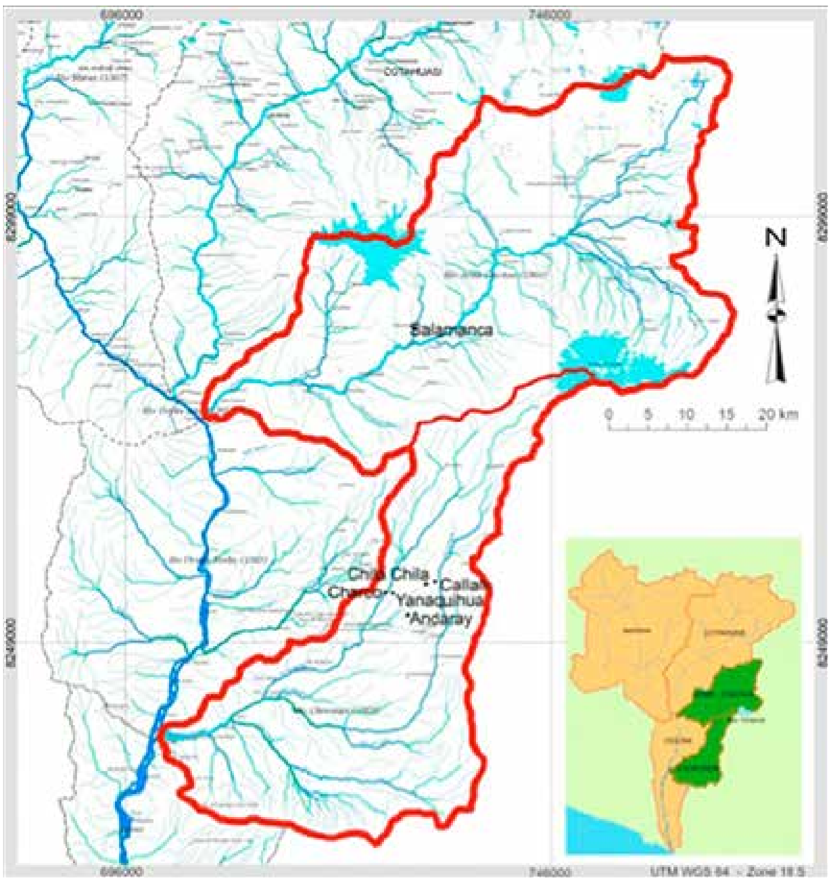
Peru is one of the countries that will be hit hardest by climate change due to its high vulnerability; the country has seven out of the nine characteristics of highly vulnerable areas listed by the United Nations Framework Convention on Climate Change (UNFCCC). The Ocoña river basin, located in the south-western part of the Peruvian Andes covers roughly 16,920 km^2 and is spread across three departments (Arequipa, Ayacucho and Apurimac) and seven provinces. The project area covers two sub-basins (the Arma – Chichas and Chorunga) located in rural mountainous areas, with altitudes varying between 464 and 6,425 meters above sea level. The area has one of the highest poverty rates in Peru.

The Coropuna glacier (the highest point in the area) has already lost 37% of its total volume over the past 34 years, and has retreated by 243 metres within this period (AEDES, 2011). Precipitation has decreased by 144mm p.a. in the last 44 years and is expected to decrease further (AEDES, 2011). In addition, the average temperature in the project area has increased by 0.30°C in the last 39 years (AEDES, 2011). Studies show that this trend will continue, making it likely that precipitation in the higher areas will change from snow to rain (Lasage et al., 2011). These aspects will affect the availability of water resources, which in turn will affect agricultural production, livestock farming and food security in the area.

The main objective of ADAPTS in Peru was to increase the resilience of families and communities to climate change by improving water availability and management in the two selected sub-basins (Arma-Chichas and Chorunga, see figure 1 below). The project utilised local knowledge of water resources and promoted sustainable use and conservation by local families and municipal governments.

Local adaptive measures, a key to farming in the Andes, include terraced slopes, catchment ponds, low cost irrigation, engineering, and community-based resource management (e.g. the conservation of native forests). ADAPTS contributed to the technical analysis of water, soil, pasture and forests, the design of water catchments and irrigation projects and to evaluating the effectiveness of adaptation measures. ADAPTS also set out to support local farmers' groups and other water users, engaging them in the design of (sub) basin management plans. Local actors in Peru, from farmers to mayors regarded the combination of support for concrete local action, research, and policy dialogue as the major strength of the approach taken by ADAPTS. Through the reforestation and irrigation projects implemented by La Asociación Especializada para el Desarrollo Sostenible (AEDES), stakeholders experienced the direct effects and benefits of implementing adaptive measures, which in turn triggered enthusiasm for becoming involved in water planning processes to ensure that a similar approach is integrated into policies.

Figure 1: Map of the Ocoña basin: the red lines delineate the areas where ADAPTS activities were carried out.



2. AREA DESCRIPTION

2.1 Description of the physical environment

The Ocoña river basin has an extensive agricultural area, 90% of which are pre-Inca terraces. Agriculture is sustained through irrigation and rain water. The region has a distinct wet (December to April) and dry (May to November) season. The growing season can last for the full year if enough water is

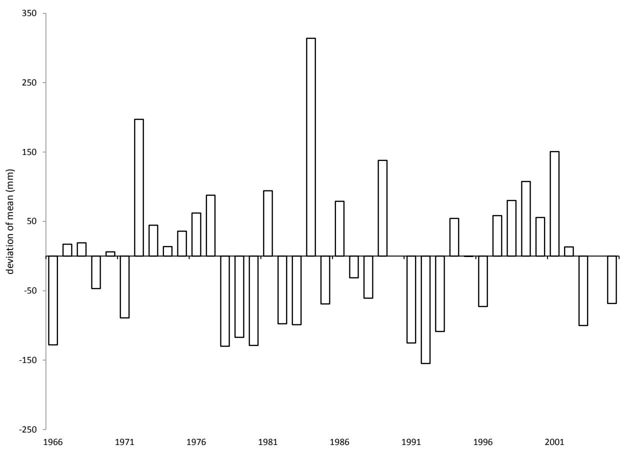
Figure 2: Traditional irrigation system (after Muis and Sardella, 2009).

available. Water from springs located in the upper part of the basin fill small reservoirs which serve as an important source of irrigated water in the dry season. The Chorunga sub-basin is a relatively dry area with limited water resources, as it is fed by the water from the springs between the months of October and December, and by one small glacier of the Coropuna. The Arma-Chichas, on the other hand, is fed by 16 glaciers from the Coropuna, and by water from the Solimana and Firura glaciers, and thus has a more abundant supply of water.

2.2 Socio-economic characteristics

The population of the Ocoña river basin is estimated at around 70,000 inhabitants, most of whom live in poverty or, as is the case of families living at higher altitudes, extreme poverty.

Peru's economy has been ranked among one of the best performers in Latin America and the world. GDP growth jumped from 3% in 2000 to 9% in 2007. Despite this, poverty rates still remain high. The main sectors of the Peruvian economy are services (59% of GDP) and industry (35% of GDP). Agriculture represents only 6% of GDP, a share which has considerably declined over the past 20 years.



Yearly deviation of mean precipitation in the Ocona basin.

The local economy in the project area shows varying characteristics. The main economic sectors include agriculture and, increasingly, mining of precious metals such as silver and gold. Other sectors include livestock breeding and small-scale commercial activities. Most households are subsistence farmers and produce for self-consumption, though there are some larger landowners who produce for the local market. Crops cultivated for human consumption include potatoes, corn, wheat and broad beans. A small portion of the population cultivates ecological products such as Kiwicha, Quinoa and Maize Morado, which are produced exclusively for export. Livestock breeding is an important source of income, and a large part of the population cultivates forage for cattle, such as alfalfa, barley and oats. Livestock include cows, sheep and pigs. Cows are bred for milk production: some milk is processed locally into cheese, but most cow owners sell their milk to Gloria S.A., a large Peruvian diary company.

3. CHANGES IN CLIMATE AND HYDROLOGY

3.1 Climate change

One of the first steps in the ADAPTS project was developing a dataset for the Ocoña basin, showing the likely changes in climate that could be expected in the 21st Century. This dataset was intended for use by, and with, regional and local stakeholders to assess their adaptation requirements and possible adaptation strategies. The dataset provided: (a) maps and graphs showing the possible short, medium, and long-term changes in annual and monthly precipitation and temperature in the study region; and (b) an assessment of the possible impacts of climate change on the discharge of the Ocoña River.

The results of two General Circulation Models (GCMs) (HADCM3 and ECHAM5) were downscaled to a resolution suitable for regional climate impact assessment (10' x 10'). Downscaled climate data were provided for a number of future greenhouse gas emission scenarios (B1, A1B, A2), and for short, medium and long-term time horizons (2006-2035, 2036-2065 and 2060-2090 respectively). A hydrological model (STREAM) was used to simulate the monthly discharge of the Ocoña. Downscaled climate data from the HADCM3 and ECHAM5 models were used as inputs.

The downscaled precipitation data for the HADCM3 model was assessed to be unrealistic, as it showed large increases in monthly precipitation, up to +300%. This was probably due to a combination of the high spatial variability in the study area together with the downscaling technique. This data was not included in the hydrological modelling exercise.

The downscaled data of the ECHAM5 model shows rising temperatures in the basin and a decrease in precipitation. Figure 3 shows the results of this study for Chichas. The three locations studied all showed a similar trend of likely change, albeit with some minor differences. The modelled runoff shows lower water levels in the Ocoña River, with the greatest reduction in the period leading up to 2075.

3.2 Hydrological system

The available water resources for irrigated agriculture in the study area are strongly coupled to the hydrological regime of several springs in the catchment. For predictions of future water availability it is important to know whether the source of the water in the springs is from glacial melt or from precipitation. Both these are predicted to decline in the future (see previous section), implying stress on the available water resources. However, the timing and magnitude of the reduction of available spring water will depend on the origin of the water in the springs. Apart from spring water we also investigated the origin of water in the rivers, which is used by downstream users including fishermen and farmers.

Finally, future water availability in the highest part of the catchment was assessed. In the high altitude areas, water is only found on the surface in small valleys, forming a type of wetland called bofedales. The Arma-Chichas sub-basin contains a vast highland plain, where bofedales can be found. The Chorunga basin has far fewer. In

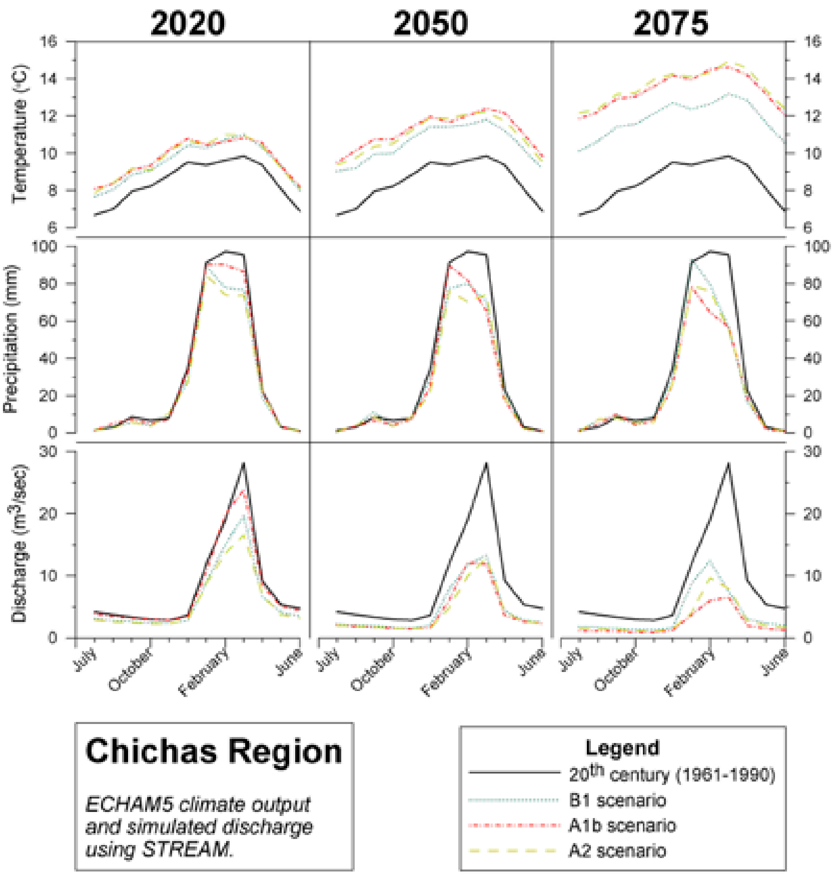


Figure 3: Projected changes in temperature, precipitation and discharge for the Chichas region for 2020, 2050 and 2075 (after Lasage et al., 2011).

both catchments we investigated whether there was a direct connection with the water found in the bofedales and the water found lower in the catchments.

The isotopic composition of water (^{18}O) can be used to indicate its origin and enables identification of the elevation at which water recharge takes place. The isotopic composition of water is determined by the precipitation composition and evaporation. As a rule the isotopic composition of precipitation changes with altitude and becomes more depleted in ^{18}O at higher elevations (Vogel et al., 1975). Evaporation influences the isotopic composition since the lighter isotopes evaporate more easily. These two characteristics allow the isotopic composition of the water to be used as a tracer to identify the origin of the water in the rivers, the springs and the bofedales.

In general, the higher the catchment the lower the ^{18}O values are, and vice-versa. In lakes and rivers we found some exceptions to this general rule. The lakes had higher values than expected, and the large rivers lower values. This shows that the water in the lakes high in the catchment had been subject to evaporation. This confirms an earlier study (INRENA et al., 2007) that showed that open water evaporation is about 1m/year. Conversely, the results show that the water in the springs and in the bofedales has not been subject to much evaporation. The predicted increase in evaporation due to temperature increase will therefore only slightly affect the amount of water available in the springs.

The change of ^{18}O with altitude in the sampled springs and small rivers indicates that the water in the springs consists of water from precipitation at altitudes similar to the springs. Additionally, a water quality analysis led us to conclude that the travel time of water surfacing from springs throughout the study area is relatively short. Electrical Conductivity (EC) -values measured at springs are very low and show little ion exchange activity between the geology and subsurface water flowing through it. These results indicate that the major source of the spring water is not melt water, but precipitation at the same altitude or 100-1000m above the springs, which flows through the soil along the hill slopes.

The water in the high plains with bofedales had a different isotopic signature than the water in the springs below. This indicates that, for the most part, the bofedales do not directly feed the springs and that the water system in the high plain is not strongly connected to the water system of the springs some 1000m below. Samples taken at the edge of the high plain and in the canyon had a signature comparable to the signature in the springs, indicating that higher altitude precipitation at the edges of the canyon may feed the springs at lower altitudes.

In the larger rivers of the two sub-basins, we found water with an isotopic signature comparable to the signature of the water at the high plains and from the glacier. This shows that the rivers contain water originating from high altitudes, most likely melt water. This suggests that under future circumstances the amount of water available in the rivers may decline, reflecting the findings of the modelling study (see section 3.1).

The water quality data showed that human activity (agriculture and cattle herding) has little influence on water quality in the springs and in the Arma River. However, in the Chorunga, the effects of human activity are evident in the water quality analysis. These are mostly from mining in the area upstream from the sampling point which had a negative impact on the water quality downstream.

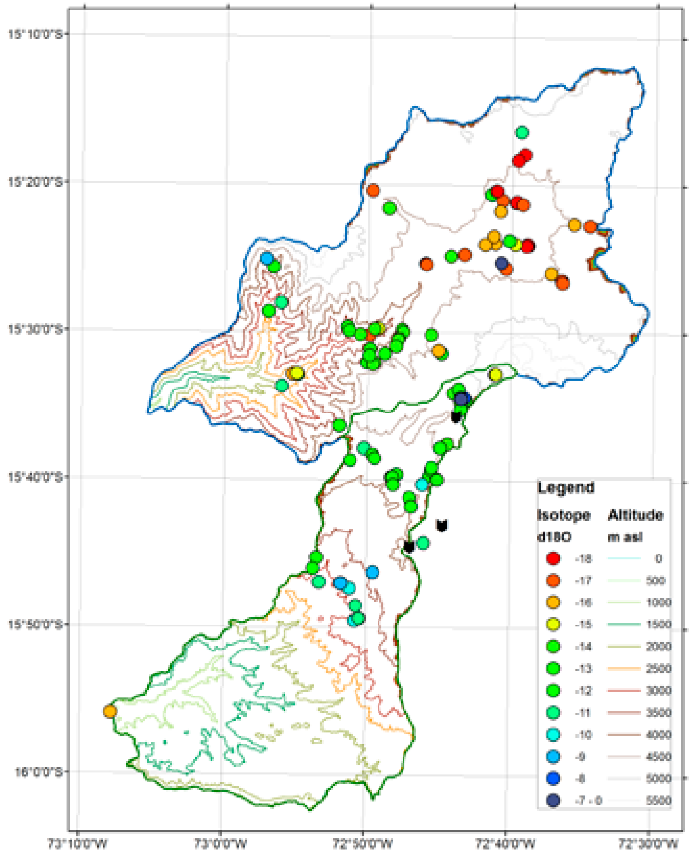


Figure 4: Overview of the ^{18}O observations in both catchments. Generally the observations show more depletion in ^{18}O with altitude. The exceptions are indicated in the figure.

3.3 Water and agricultural production

An analysis was carried out to see how production of the main crops grown in the Ocoña basin might change under the projected climate changes. The main results show that all crops will be exposed to water stress under climate change, and that production will probably decrease if farmers continue with their current ways of working (see Singh, 2009). The results also showed that rising temperatures would mean that some crops, such as maize and potato, could be grown at higher elevations.

3.4 Vulnerability to climate change

In 2009, a base line study for water use and climate change vulnerability was carried out in both sub-basins (see Muis & Sardella, 2009). A more in-depth analysis was carried out for the Chorunga basin to assess the vulnerability of households to a reduction in water availability. This showed 4 significant household characteristics (income, economic situation, education and area of irrigated land) that influenced vulnerability (as shown inTable 1: Spearman correlations for the vulnerability of households in the Chorunga sub-basin (N=94) (Muis and Sardella, 2009) Table 1. These variables are all negatively correlated.

Further evaluation of these results indicated that a household's access to water for irrigation was the most important factor determining household vulnerability. This also explains why households in the Chorunga basin were on average more vulnerable to droughts than households in the Arma-Chichas basin. These results contributed to the decision to focus most of the activities of the ADAPTS project in the Chorunga basin, and to focus on improving water availability (e.g. by increasing storage capacity) and promoting the efficient use of water (e.g. drip irrigation, preparation of the land, etc) (Belinfante, 2009; Muis & Sardella, 2009).

Household characteristics	Vulnerability	
Age	Corr. Coef.	0.11
	Sig.	0.29
Education	Corr. Coef.	**-0.23***
	Sig.	**0.03**
Economic situation	Corr. Coef.	**-0.24***
	Sig.	**0.02**
Income	Corr. Coef.	**-0.25***
	Sig.	**0.02**
User size	Corr. Coef.	-0.19
	Sig.	0.08
Irrigation frequency	Corr. Coef.	0.08
	Sig.	0.46
Area irrigated land	Corr. Coef.	**-0.20***
	Sig.	**0.05**
No. of cows	Corr. Coef.	-0.10
	Sig.	0.36
* Correlation is significant at the 0.05 level (2-tailed)		

Table 1: Spearman correlations for the vulnerability of households in the Chorunga sub-basin (N=94) (Muis and Sardella, 2009)

4. INTERVENTIONS

AEDES is currently helping local authorities, such as the Andaray municipality (in the Chorunga sub-basin) to improve water management in water-scarce areas. ADAPTS has been supporting this process by raising awareness about climate change and the need to improve local water management practices. There has been a focus on helping to build the capacity of local water users (mainly farmers and foresters) to improve their irrigation systems and to choose marketable crops that are suitable for the local physical circumstances.

4.1 Irrigation

The irrigation distribution system currently in use in the project area is a traditional one that pre-dates Peru´s agrarian reform. Rights to water and to land are inherited separately. Water rights are organised according to an irrigation distribution cycle (turno) which guarantees each farmer access to water for a specific field only once in a cycle - which can last as long as 60 or 70 days. When farmers receive their water allotment, they receive a lot of water at once. Many irrigate by flooding their fields, which results not only in water waste by also in soil erosion on their sloping fields. Water rights are unequally distributed in the Andaray project area, where they are concentrated in the hands of a few families, while other farmers have very limited rights to irrigation water.

One example which shows the need for improved awareness is the current system of dividing water rights. These rights are organised in a way that give farmers access to water only once every so many days, a system based on a long-standing tradition and therefore one that is quite difficult to change. Within this system, each farmer has a different amount of (inherited) water rights that gives them access to water for a number of hours or days in each cycle. For some farmers this means they only get water once every 78 days or so. When they receive their share, they take as much as possible and either flood irrigate or irrigate via gravity, thus wasting water and causing soil erosion. In such a dry area, a more balanced system of irrigation could make a big difference.

Figure 5: Newly installed drip and sprinkler irrigation systems.

AEDES is supporting the newly created Coropuna-Solimana Irrigation Water Board (Junta de Usuarios Coropuna – Solimana), which is a legally recognised local institution, charged with organising the distribution of water for irrigation, collecting user fees and maintaining irrigation infrastructure. It covers the thirteen irrigation commissions within the ADAPTS project area. The board receives financial support from the government and other donors, as well as from water users, which allows it to maintain an office and infrastructure and hire a technician to assist the commissions and farmers to improve the efficiency of their irrigation systems. AEDES supports the Chila Chila and Andaray irrigation commissions in their efforts to re-organise the traditional system of water distribution by making the cycle shorter so that farmers can have more frequent access to water (for shorter periods). These changes reduce the need to borrow (or buy) water and enhance the efficiency of water distribution along canals and within fields. In neighbouring regions the water boards typically work in close coordination with government technicians from the local branch (Local Water Administrative Agency) of Peru´s recently created (2009) National Water Authority (ANA). This working relationship strengthens institutional links and creates opportunities for jointly promoting climate change adaptation through better irrigation practices.

ADAPTS has also supported a number of pilot projects, using drip and sprinkler irrigation (often combined), to show local farmers and the broader community (e.g. through a school project) that mechanised irrigation can increase the efficiency of water use, making it possible to double or triple the area of irrigated land, thereby leading to higher incomes. With support from AEDES, a number of farmers/ livestock owners have introduced new irrigation techniques on their plots. Almost all the pilot projects asked the beneficiaries to contribute to the cost of these investments. The farmers involved, who are village leaders in the area, were generally willing to contribute half % of the $1,750/ hectare investment. (This cash contribution is in addition to the farmer's labour investment). The pilot projects were designed and implemented by AEDES in order to reduce costs and avoid duplication of effort. AEDES hopes that these pilots will convince more farmers in the region to change to more efficient irrigation systems.

One farmer in Andaray, called Henry, upgraded his irrigation system in 2010. A basin with a capacity of about 380 m^3 was installed on his plot to collect the water he accesses through his water rights, which give him access to water once every 60 days or so. He also installed both drip irrigation and sprinklers. The basin has allowed him to increase the irrigated area from 1.5 to 2.5 hectares (on a plot of 4 ha), with a further increase planned. His new irrigation system has allowed him to fine-tune the water provision to needs of the different crops and to diversify his crops. He has already planted and harvested a new commercial crop - garlic – which he has sold at the markets of Andaray. He is now planning to invest in new crops, such as maize and tomatoes. Another farmer, specialised in milk production, installed a similar system and expects to double his production of fodder and thus increase the number of cows from 4 to 6 in the near future.

4.2 Micro-dams and bofedales (high altitude wetlands)

The ADAPTS project has also been instrumental in constructing four micro-dams in the higher altitude regions of the project area. The small-scale reservoirs created by these dams store water during the wet season, to be used in the dry season. The capacity of the reservoirs ranges from 110,000m^3 to 220,000m^3. The municipalities contributed most of the money required. For the last dam constructed, the municipality of Andaray contributed the machinery and manpower, and AEDES provided the technical knowledge and shared supervision of the construction work (AEDES, 2010).

These new dams serve several purposes. The highest dam in the catchment, at about 4900m, was built to restore and increase the area of bofedales (high altitude wetlands). These bofedales are an important source of food for the llamas and alpacas which are herded at these locations. It is anticipated that this reservoir will recharge the bofedales below by natural infiltration of the water in the reservoir to the valley below. If this does not work, the water can be sent down the hillside in the dry period using existing small channels. The reservoir can also be used to water cattle when they are on high pastures. This is expected to increase the quality of livestock as it will mean they will not have to roam over such large distances in search of fodder and water.

The other reservoirs are located a little lower, but are still high in the catchment at about 3900-4300m. Apart from providing drinking water for cattle, these reservoirs are also used for water during the dry period and to irrigate fodder production. One dam will also provide water for a reforestation project (see following section). The water from these reservoirs is stored high in the mountains, and is used at lower altitudes where the higher temperatures allow more plant species to grow. It will be transported along small channels and existing small river systems. Because the amount of precipitation increases with altitude, it makes sense to collect and store water at higher altitudes rather than at the location where it will be used. Each reservoir is expected to increase the amount of irrigated land by about 5 ha in the future. This is less than the benefits experienced by the farmer described in section 4.1. This is because the large reservoir is only filled with water once per year (in the rainy season), as opposed to several times per year, and about half of the stored water in the large reservoir will be lost to evaporation. Also the farmer has improved his irrigation methods, while the water from these reservoirs will be used for gravity (flood) irrigation.

Figure 6: Micro dam at 4900m.

4.3 Reforestation

Polylepis

In water-scarce areas, reforestation or forest conservation can also play a valuable role in coping with climate change. ADAPTS has supported the protection of forests and reforestation in three different ways. The first is by protecting the Polylepis tree. This tree, commonly known as queñua or quewiña, is a tree that frequently grows at or even above the natural tree line in the Andes. Polylepis forests exist primarily in small and widely isolated fragments, which are being rapidly depleted by rural communities. Polylepis is valued by the population as it delivers high quality charcoal, which is mostly used for roasting chicken. This popularity has led to a situation where the Polylepis is in danger of extinction. AEDES' efforts have led a number of Polylepis forests becoming recognised as Private Conservation Areas (Âreas de Conservación Privada or ACPs) by the Peruvian Government, and these are now managed by local communities. Fencing off areas of Polylepis forest has allowed the young plants, which are often eaten by llamas, to grow, thereby giving the species a better chance of survival.

Tara

Tara is a species that is well-adapted to the local environment as it needs limited amounts of water. The spines form a good natural barrier for fencing off agricultural plots. The seeds it produces are of high value, are used in many industries (including cosmetics, medicinal, paints, shoe polish, etc.) and are exported. The largest project involving the planting of Tara is taking place in close cooperation with a local school. This project has three purposes: educational, reforestation and commercial. Once the Tara plants have grown, avocado trees will be planted on the same plot, protected from the winds by the Tara and increasing the commercial value of the project. When fully grown (after about 4 years) the Tara plants will provide to an income for the school and the farmers who manage them.

Figure 7: Pine tree nursery (AEDES, 2010b)

Pine trees

Pine trees are also being grown and planted at higher altitudes. A community group which has worked on reforestation for over a decade received support to expand their work, widening their activities from planting eucalyptus trees near the river and the homes of community members. A system was developed to use the water from a newly constructed basin. The community was advised to stop planting eucalyptus, a tree that needs a lot of water, and to plant pine trees instead. Pine trees only need irrigation two to three times a year, in addition to natural rainfall. Economically, the community benefits from this project because of it will provide fodder for their llamas. Other expected benefits are the mushrooms which can grow on pine trees (after 3 years or more) and which can be sold on the market and the commercialisation of pine wood after about 10 years.

4.4 Drinking water systems

Three water systems were constructed close to the households of families with limited access to drinking water, with the aim of reducing the time spent by women and schoolchildren collecting water. The first water system was built on the Apañe stream, and consists of a dam of reinforced concrete which allows it to retain the sand from the stream bed and to store water in the sand's pores. AEDES learned this technique from Action for Development, the Ethiopian partner in the ADAPTS project. The second and the third systems consist of engineering works that allow the collection of water drained from the roofs of the houses and subsequently stored in underground tanks. Thanks to these systems the beneficiaries will be able to rationally use their collected water all year round (AEDES, 2010b).

5. DIALOGUE

5.1 Water governance

The Peruvian government has only recently become involved in water resource management. In March 2009, the government approved the Water Resources Law (Ley de Recursos Hidricos). This law aims to establish the integrated management of water resources, which were previously managed under a sectoral approach. It led to the creation of the "Autoridad Nacional del Agua" (ANA, or National Water Authority). This governmental body is responsible for the integral management of water resources, the technical coordination of the system, and overseeing legal compliance. Its principal functions are the formulation of a national water management strategy, which includes the administration of water resources, the formalisation of water rights, and the control of water quality. At the moment, two ministries are responsible for ANA: the Ministry of Agriculture (water quantity and distribution), and the Ministry of Environment (water quality). The figure below shows the relation between different water users' organisations in a basin, under the new law.

In 2009 a start was made on creating a structure for developing an Integrated River Basin Management Plan in the Ocoña basin. However, these activities were put on hold due to uncertainties over how the process should be organised.

5.2 Regional and local level dialogue: sub-basin management plans

As part of the Water Law, water basin boards (Consejos de Recursos Hidricos de Cuenca) will be formed to determine

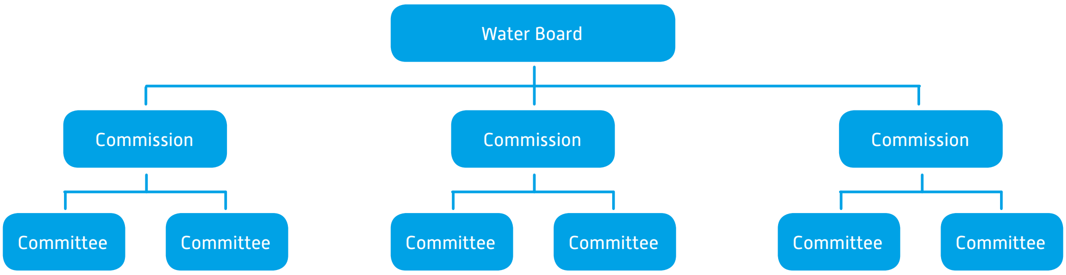


Figure 8: Structure of water users' organisations under the new General Water Law of Peru (after Muis & Sardella, 2009).

basin management plans. In Peru, consejos will be formed for a total of 159 basins. Ten such consejos will be financially supported by the national government (through World Bank and Inter-American Development Bank funding). The choice over which basins to support was largely determined by economic interests. To date, only two consejos (Chira-Pura and Chancay Lambayeque) have been formally established.

Ocoña, a basin with high rates of poverty, was not one of the basins selected. It stretches from the Andean highlands to the coast and passes through a number of (physically and economically) diverse regions, making it is a relatively complex basin to form a consejo for. To ensure that all stakeholders participate and have a say in the management of the basin, ADAPTS chose to take a different approach: building up the Ocoña basin management plan in a bottom-up and participatory manner.

Through a regional agreement, the regional government of Arequipa declared the necessity and regional interest in creating Consejos de Cuencas Regionales y Interregionales. From the outset ADAPTS chose not to work at the level of the entire basin, but focused instead, on the establishment of consejos for four sub-basins, which will jointly form the basis for the Ocoña basin management plan. AEDES cooperates with the regional authority - Autoridad Regional del Medio Ambiente (ARMA) - in trying to establish the consejos for the Chorunga and Arma-Chichas sub-basins. In December 2011, a meeting was organised with the stakeholders (mayors, representatives of the mining and the agricultural sector) of these two sub-basins in order to establish a joint management plan that will feed into the process of establishing a plan for the entire basin.

5.3 National dialogue

The Ministry of Environment (MINAM) has shown interest in the ADAPTS project, since it is one of the few projects in Peru which has begun to implement climate change adaptation measures. The new Water Law provided a timely opportunity, coming as it did, at the beginning of the project. ADAPTS organised a meeting where policymakers and civil servants could learn about the potential for climate change adaptation in the Peruvian context. The project team was also invited to share experiences and insights at the national forum on water and climate change, held in Lima in 2010. The recent change of government following the election of President Humala (who took office on the 28th of July 2011) led to a period of uncertainty about whether previous policies will continue and how. Given the ensuing lack of clarity about national policies, ADAPTS has directed most of its efforts to building up direct working relations at the local and regional levels. The results of this work, still in need of firm consolidation, were said to have provided national policymakers with food for thought on how to organise and institutionalise processes at the sub-national level.

In light of this, on December 18, 2011, ADAPTS organised a meeting in Lima with decision makers and representatives from the Ministry of Environment, ANA, the Dutch embassy, the Inter-American Development Bank, and USAID, to present the results of the ADAPTS project in the Chorunga and Arma-Chichas sub-basins and to discuss possibilities for upscaling. Interest was shown in the idea of working on river basin management plans beginning at the sub-basin level.

6. CONCLUSIONS

The ADAPTS project in Peru contained a number of inter-linked components which together represent a number of important steps towards integrating climate change into water policies at the level of the Chorunga and Arma-Chichas sub-basins.

Firstly, research into the local effects of climate change and the hydrological structure of the project area has improved understanding of the most effective ways to help the local population adapt to climate change. To ensure that these efforts are sustained, there is need for more national involvement in investigations, for example in continued monitoring of the glacier Coropuna's retreat and the longer term effects of the pilot projects. The need to better align the curricula of universities (e.g. those of Arequipa) with local demand (i.e. studies on water resources and irrigation) has been raised both in Arequipa and at national level.

Secondly, through the implementation of low-cost pilot projects, ADAPTS has shown positive results in terms of sustained availability of water and the possibility of increasing the area of land used for agricultural production (including fodder). In this way, ADAPTS is already contributing to socio-economic changes at the local level for a number of farmers and livestock herders. These results should show up more clearly over the coming period, when the changes in irrigation systems are expected to lead to actual increases in the production of agricultural products and milk and the diversification of crops. An impact assessment on both livelihoods and the environment needs to be carried out to get a real insight into the effects, benefits and costs of these activities. This should follow up on the base line survey that has already been carried out as part of the ADAPTS project.

The pilot projects are not only important for their direct effects on the farmers involved, but also because they help to create enthusiasm among families, communities and municipalities for engaging in changing the current water management system. While more investment is needed to improve the irrigation systems, it is also necessary to create institutional structures, such as sub-basin management boards and plans, and to address adaptation issues. Other key organisations, such as irrigation and water boards have a key role to play in bringing about the needed changes, but they need strengthening further in order to function better.

A third important element of ADAPTS lies in the links it has forged with institutions at different levels. The project has built relations with SERNANP, the climate change office of MINAM, which supported the creation of two ACPs "Âreas de Conservacion Privada" (Private Conservation Areas) managed by the local communities, the municipality of Andaray, the glaciology unit of Huaraz-ANA, and the regional government of Arequipa (ARMA), which has cooperated in the process of designing a management plan for the sub-basins. Some progress has been made in beginning the process of developing sub-basin management plans for the Chorunga and Arma-Chichas. AEDES has been able to secure follow-up funding to continue with this process. This approach, beginning at the sub-basin level in order to create a river basin management plan for the entire Ocoña basin, has attracted the interest of other influential players and when it shows its effectiveness, it might become a model for other Peruvian river basins.

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