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Mountain communities' perception of Climate Change Adaptation, Disaster Risk Reduction and Ecosystem-Based Solutions in the Chicón Watershed, Peru

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Abstract

Located in the Urubamba mountain range, the Chicón glacier is the third highest tropical glacier of the area and the source of water for the Chicón watershed. Moreover, from this watershed four communities obtain water for human consumption and agriculture, which is their main economic activity. In the last few years glacial retreat is evident in the area and threatens the livelihoods of mountain communities because it affects the availability of fresh water.

The general objective of this research is to analyse the perception of people living in this watershed on the impacts of climate change and climate-related disaster risk as well as the role of ecosystems for risk mitigation. The specific objectives are to identify natural hazards and the effects of climate change in the community, to recognise potential ecosystem services suitable for Ecosystem-based Adaptation (EbA) and Ecosystem-based Disaster Risk Reduction (Eco-DRR), and to assess which effects of climate change and disasters the communities are most vulnerable to, based on their own perceptions. Methods include literature review, expert interviews, a household survey, a workshop with local residents, and field observations.

The results show that people perceive changes in the climate such as an increase in temperature, lower precipitation and shifts of the rainy and the dry seasons. Climate-related disasters that were identified are Glacier Lake Outburst Flood (GLOF), droughts, frosts and hailstorms. However, GLOFs are not frequent in the area and drought is the hazard that people expect will be more frequent. Additionally, pests were identified as biological hazards. Several ecosystems services can be obtained for EbA and Eco-DRR from forests, especially if native trees such as Qiwiña (*Polylepis spp*.), Chachacoma (*Escallonia resinosa*) and Aliso (*Alnus jorullensis*) are used in ecosystem management. People in the study area are to some extent aware of the impacts of climate change, but only partially understand the causes and effects. Further, they recognize most of the ecosystem services that forests provide. Therefore they are starting to implement ecosystem-based solutions in the watershed with the support of external institutions.

Keywords: Climate Change, Disaster Risk Reduction, Ecosystem-based solutions, Perception of communities, Chicón watershed.

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Introduction

Peru contains 71% of the tropical glaciers in South America, which are distributed across 19 mountain ranges. The Chicón glacier is one of the 117 glaciers located in the Urubamba mountain range in Cusco, Peru (ANA, 2014). With an altitude of about 5,530 m.a.s.l., Chicón is the third highest mountain in the region and has one of the biggest portions of tropical glaciers of the country. The site is located in a subtropical highland climate zone with two defined seasons. The dry season lasts from May to November while the rainy or wet season begins in December and ends in April, with an average temperature range from 11 to 16° Celsius (INDECI, 2005). The water coming from this glacier flows through the Chicón river and four rural communities make use of it. The main economic activities of these communities are agriculture (primarily corn and vegetables) and livestock rearing. According to the last population census of Peru, in 2007 the Urubamba district had a total of 17,787 inhabitants of which 34% live in rural areas (INEI, 2007). The settlements are surrounded by pine (*Pinus sp.*) and eucalyptus (*Eucalyptus sp.)* plantations. Due to the closeness of the communities to the Chicón glacier they are vulnerable to the effects of glacial retreat (INDECI, 2005). Climate change is increasing the risks of climate-related disasters that harm people's livelihoods, assets, economies and safety (Munang et al., 2013). Glaciers are important water sources for communities, especially nowadays, as the water demand in these watersheds is rising due to irrigated agriculture expansion and population growth (Drenkhan, 2016). Therefore, this research aims to identify the perception of these communities to use ecosystem-based solutions for climate change adaptation and disaster risk reduction, as ecosystems provide many services including natural protection against hazards, climate and water regulation, carbon sequestration, and pest regulation (Munang et al., 2013).

Material and Methods

The research was conducted in four communities located in the Urubamba province: San Isidro de Chicón, Yanaconas, Chichubamba and Ccatan Pino. These communities were selected based on their location in the upper and the lower part of the watershed, to identify if there are differences in the perception of climate-related risks. Qualitative data was collected using secondary and primary sources. The data was collected from a literature review, expert interviews, a household survey (113 respondents), and a workshop with local residents using a methodology from CARE International (CARE International, 2009).

Results and Discussion

Perception of Climate Change

Results show that 99% of the participants perceive changes in the climate. One of those changes is the temperature; 63% of the people perceive warmer temperatures than before, 25% of the people think that the temperatures are more extreme. Climate studies prepared by SENAMHI, show that between 1965 and 2010 the maximum annual temperature has increased +0.5 °C in the Urubamba watershed while the minimum annual temperature has increased +0.2 °C (SENAMHI, 2012). This fact supports the theory of warmer days but not colder nights. Concerning changes in the rainfall regime, shifts in the rainy and dry seasons are evident and thus less rainfall during the wet season. These changes in temperature and rainfall regime are mostly recognized by 72% of the participants in the last 10 years. The study also revealed that the most critical months are May, June, July, August and September (dry season). During this period the communities face water shortages for crop irrigation, and cold waves that affect the health of both children and the elderly. Dry spells also negatively affect crops that are sensitive to low temperatures and as a consequence the price of food increases. However, in the available data of the Urubamba watershed precipitation has been constant in the last 50 years and there is no clear evidence of decreases in precipitation in the last 10 years at this level.

Perception to Hazards, Disasters and Implemented Measures

Figure 1. Participatory Hazard Map of the Chicón watershed

Hazards were mapped in the workshop by the women from the communities (see figure 1). They identified GLOFs as the main hazard in the watershed. These findings are supported by the Hazard study of the Urubamba city, which reveals that the communities with very high risk to GLOF are the ones located in the upper part of the watershed (San Isidro de Chicón and Yanaconas) as well as in Chichubamba (INDECI, 2005). Likewise, droughts are a growing problem that generate water conflicts among users, and affect mainly those communities in the lower part of the watershed (Chichubamba and Ccatan Pino). Frosts are less frequent than other hazards but they lead to large crop losses, particularly in San Isidro de Chicón and Yanaconas. Finally, pests were identified as biological hazards in all the communities. GLOFs cause high impact in the study area; however they have occurred only in 1679, 1942, 2010 and 2011. People agree that disasters have not increased in the Chicón watershed but they predict that drought will be more frequent in the future.

The research revealed that many people from the watershed believe that the 2010 GLOF was manmade, because people wanted to extract minerals from the Chicón glacier and only few people link the GLOF to climate change (Tecsi and Tupa, 2017). After the 2010 GLOF the government implemented different measures to reduce risk. From those solutions the most known is river channelling, followed by the retaining wall, early warning system and evacuation routes. It is important to note that almost half of the participants do not know these measures. Lastly, people know how to respond to GLOFs but they are not prepared to respond to droughts.

Vulnerability to Climate Change and Disasters

The resources that were found to be more vulnerable to disasters are crops, land, animals and food. GLOFs are the hazard that has a higher impact on resources, followed by droughts and frost. During the dry season, the most vulnerable communities in terms of agricultural vulnerability are Ccatan Pino and Chichubamba, since they are located in the lower part of the watershed. The communities also face institutional vulnerability as there is not enough participation from the Ministry of Agriculture or the Civil Defense. They perceive that support from government institutions to adapt to climate change is limited. With respect to risk mitigation, the respondents consider the community and the local government as very important. Moreover, a report from PREDES (2011) shows that the majority of houses are made of adobe, which collapses when it is saturated by water, as seen in the 2010 GLOF. Vulnerability of people to GLOFs is high since many people from San Isidro de Chicón and Yanaconas live on river banks.

Ecosystems services suitable for EbA and Eco-DRR

The Chicón watershed contains natural resources such as the Chicón river, native forest, eucalyptus and pinus plantations, the Chicón glacier and the land. Households perceive a reduction in river flow, forest cover, glacier surface and land fertility, but is not clear when these changes started. According to ANA (2014), about 62% of the Chicón glacier mass has been lost since 1970.

Communities' acceptance of ecosystem-based solutions is a key factor for their implementation. It was found that native forest can help to mitigate and adapt to climate change, and at the same time to prevent disasters in the future. In this regard, the role of the forest was recognized by 97% and 94% of the respondents. At the beginning of 2017, the communities did a reforestation campaign for climate change adaptation and protection of the watershed. The native species that were mentioned most of the time by communities are Qiwiña (*Polylepis spp.*) which grows in poor soils, tolerates high stoniness and requires little water, Chachacoma (*Escallonia resinosa*) that responds well to poor and degraded soils, and tolerates droughts, and Aliso (*Alnus jorullensis*) which is used for soil recovery in the Andes mountain range (Arica, n.d.).

Conclusions and Outlook

This research shows that communities of the Chicón watershed are aware of climate change. They also recognize GLOF as the hazard that threads the majority their livelihoods, but not likely to happen again as they believe that the last one was provoked by humans. Moreover, droughts and frosts are the disasters they expect to occur most frequently, affecting all communities as they depend on agriculture. All their resources (crops, farms, animals and food) are vulnerable to GLOF, droughts, frosts and hailstorms. These findings overlap with scientific studies on risk in this area.

The native species mentioned by the locals, such as Qiwiña (*Polylepis spp.*), Chachacoma (*Escallonia resinosa*) and Aliso (*Alnus jorullensis*), provide various ecosystem services and are often used for soil recovery in the Andes to protect water and regulate microclimate. People are aware of some of the benefits that native forest brings and show willingness to implement ecosystem-based solutions. Moreover, it was found that climate change can increase disasters such as droughts and GLOFs in the Chicón watershed. People in the study area are aware of climate change impacts, but they only partially understand causes and effects. However, the assertion that ecosystem services for climate change adaptation and disaster risk reduction are also not fully understood and therefore ecosystem-based measures remain untapped is false, as people have reforested the upper part of the watershed.

Further research can be done in the Chicón watershed using data on precipitation and temperature from the local level, in order to have a more accurate analysis, as the one used in this research was from SENAMHI reports of the Urubamba watershed which is a bigger area. The participatory map can be used to design ecosystem-based adaptation measures.

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