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# **Final Report: Assessment of Climate Change Adaptation in the Metropolitan Area of Arequipa**

CityLinks Diagnostic Assessment

Disclaimer: This report was prepared with input from USAID, Peruvian private and public sector officials, institutions, and organizations, and ISC. The views expressed in this report are those of ICMA and do not necessarily represent those of USAID or any other person or organization associated with this report.

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## **LIST OF ABBREVIATIONS**

AAA - Autoridad Administrativa del Agua

AEDS - Asociación Especializada para el Desarrollo Sostenible

ALA – Autoridad Local del Agua

AMDA - Asociación de Municipalidades Distritales de la Provincia de Arequipa

CAM - Comisión Ambiental Municipal

ICMA – International City/County Management Association

INDECI – Instituto Nacional de Defensa Civil

INEI – Instituto Nacional de Estadística e Informática

ISC – Institute for Sustainable Communities

SGRD - Subgerencia de Gestión del Riesgo de Desastres de la Municipalidad Provincial de Arequipa

SNMHP - Servicio Nacional de Meteorología e Hidrología del Perú

# 1. Executive Summary

The metropolitan area of Arequipa (herein referred to as Arequipa or Metro Arequipa), which is comprised of the 19 municipalities that make up the principal urban area of the Province of Arequipa, experienced an extreme rain event in February 2013. This event caused severe damage to infrastructure and human fatalities, and made city dwellers, authorities, and civil society stakeholders more aware of the extreme vulnerability of Arequipa to climate change effects. At the request of USAID/Peru, CityLinks™, under the leadership of the International City/County Management Association (ICMA), and its partner the Institute for Sustainable Communities (ISC), conducted a ten-day rapid assessment to identify the challenges and opportunities Metro Arequipa faces in adapting to climate change, and to develop a set of recommendations for the USAID Mission in Peru to consider to further assist Arequipa in addressing those challenges.<sup>1</sup>

The assessment identified risks, vulnerabilities, and potential impacts affecting people, assets, and the physical environment of Metro Arequipa. The compressed timeframe and lack of data at the local level constrained the team's ability to establish definitive causal links between climatic changes and resulting hazards and impacts. Nevertheless, it was possible to gain sufficient understanding of the situation to identify trends, challenges, and opportunities that could assist Metro Arequipa build its capacity to ameliorate the current impacts, and thereby reduce future risk and concomitant losses.

**Major Findings.** The major climatic hazards affecting Metro Arequipa are glacial melt, and changing temperature and precipitation patterns within the region. These new patterns appear to be correlated with changes in agricultural production, accelerated rural-urban migration, and reduced benefits from existing infrastructure, thereby increasing the vulnerability to people and infrastructure in the urban area to the effects of climate change.

Glacial melt, for example, is affecting available water to supply to the dams that provide water and hydroelectric power to Metro Arequipa. Nevertheless, the shift from hydro to fossil fuel energy production can be expected to contribute over time to increases in air pollution and therefore negatively affect the health of the urban population, as well as to black soot and greenhouse gas emissions that would accelerate glacial melt. Temperature and precipitation changes have simultaneously produced more drought in some parts of the region, and torrential rains in other parts relative to past patterns. These changing weather patterns have affected agricultural production, contributing to increased rural-urban migration and raising the probability of future urban food security problems, particularly for low-income populations; and appear to be contributing factors to the increase in urban flooding, as the traditional storm drainage systems (*torreteras*) become overwhelmed.

Urban population growth in Metro Arequipa will further exacerbate the risks associated with climate-related hazards, as more people; and social, economic, and physical infrastructure become exposed and vulnerable. The risks are further aggravated by two important factors: 1) the institutional weaknesses within Metro Arequipa and its inability to address the climate change challenges affecting issues internal to the Provincial Municipality of Arequipa (sometimes referred to as Municipality of Arequipa) – the lead municipality within the metropolitan area; and 2) the Municipality of Arequipa's weakness in exercising its leadership role to collaborate and coordinate strategy and programs with the surrounding municipalities that comprise the metropolitan area, along with the private sector and other key stakeholders within the Metro Arequipa area.

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<sup>1</sup> The scope of the assessment is on climate change adaptation, which excludes consideration of climate change mitigation issues, such as green house gas emissions, solid waste management, and other actions designed to alter the course of climate change.

Urbanization, with its concomitant increase in energy use to support population and economic growth, also likely contributes to increases in greenhouse gas emissions and other pollutants that over time will exacerbate the glacial melt, putting additional pressures on hydroelectric power generation and urban water supply. The cumulative effect of this dynamic interaction and feedback loops between climate change and urbanization can be expected to lead to increased intensity and frequency of extreme weather events, such as that which led to the 2013 flooding.

In assessing Metro Arequipa's ability to adapt to these changes, the team identified weaknesses with the Municipality of Arequipa that have prevented a more robust pro-active approach to the Metro Arequipa urban climate adaptation problems: lack of effective urban land-use and infrastructure planning; inadequate regulatory enforcement or land use and zoning regulations; lack of inter-jurisdictional coordination; and lack of a proactive climate-related disaster prevention, warning, and response system. Taken together, these deficiencies have exacerbated Arequipa's vulnerability to weather-related hazards, with concomitant risks to Metro Arequipa's urban social, economic, and physical infrastructure. For example, although the magnitude of rainfall in February 2013 would have overwhelmed even a well-managed storm drainage system, the failure to adequately maintain and protect the urban storm drainage system, which was shared and co-managed by other jurisdictions within the metropolitan area, exacerbated the flooding problems and increased significantly the risks to people and structures located within the floodplain of the drainage system.

**Conclusions.** Although Metro Arequipa faces a number of climate change risks and vulnerabilities, the institutional issues for developing coordinated metropolitan-wide strategies and programs are the most important factors falling within the manageable interest of the Provincial Municipality of Arequipa. In this regard, the team believes that the highest priority should be given to developing a program to mitigate the effects of flooding within the metropolitan area. If left unaddressed the risks and vulnerabilities associated with the flooding will continue into the future, resulting in increasing losses over time. The Municipality of Arequipa needs to become more proactive and forward-looking by integrating climate-related vulnerabilities and risks into its and the metropolitan-wide land-use and infrastructure service planning, taking into consideration projected urban population growth and settlement patterns, as well as potential shifts in frequency and severity of weather-induced disasters due to climate change.<sup>2</sup>

The ability of Metro Arequipa to address climate adaptation issues that contribute to the flooding are complicated by several factors: 1) weak intra-municipal coordination among the various departments and services within the Municipality of Arequipa; 2) lack of adequate coordination and communication with the provincial and national governments, as well as with the other municipalities with Metro Arequipa; and 3) lack of coordination between the public and private sector stakeholders more broadly within the metropolitan area. Numerous stakeholder interviews during the assessment substantiated this conclusion by citing the need for building local public and private sector capabilities to improve Arequipa's urban climate change adaptation capacity. Improving this internal and intra-jurisdictional coordination, therefore, needs to be a priority, as well.

**Recommendations.** The key to improving the capacity of Metro Arequipa rests with improving the capacity of the Municipality of Arequipa, which is the lead municipality within the metropolitan area. In the short term, USAID could focus on improving the Municipality of Arequipa's capacity to play a leadership role in dealing with the direct impacts of climate change – i.e. the flooding caused by the torrential rains, and in particular focusing

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<sup>2</sup> While potentially improved inter and intra-institutional performance could improve the capacity of Arequipa to address broader and more indirect effects of climate change, those actions, which may involve improved watershed management to reduce stress from glacial melt, or reduce green house gas emissions in urban areas are beyond the scope of this assessment, either because the actions are rural focused (watershed management), or deal with climate change mitigation issues (emissions).

on the management of the *torrenteras* and controlling land use in the *torrentera* floodplains. Over the medium to longer-term, USAID could help Arequipa deal with some of the more indirect impacts, such as threats to public health urban food security and unsustainable development path dependencies created by increased pollution and decreased agricultural production in the surrounding region. The scope of USAID assistance will depend on the extent to which the Mission has funding for a longer-term, multiyear program that could help Arequipa better assess risks; and design, finance, and manage adaptation and/or mitigation programs that address these longer-term risks.

The assessment team recommends a phased approach, whereby initially CityLinks focuses on building the local capacity that would allow the Municipality of Arequipa to play a leadership role in improving the Metro Arequipa region's ability to integrate climate change adaptation into its disaster risk reduction and preparedness program with a focus on improving management of the storm drainage system. A well-functioning multijurisdictional storm drainage system will also require the Municipality of Arequipa to develop an integrated approach within its municipal government; as well as take a leadership role in working with diverse stakeholders within and across municipalities within the region, as well as with different levels of government to forge a coherent approach to improving the storm drainage system.

ICMA's CityLinks program is uniquely positioned to support USAID's efforts through its time tested city-to-city partnerships, and capacity building efforts that strengthen local organizations to serve as support to the local governments. By providing the Municipality of Arequipa, and potentially other municipalities within the Metro Arequipa area opportunities for peer exchanges coupled with direct technical assistance and training to key stakeholders, CityLinks could help the Municipality of Arequipa, and by extension Metro Arequipa to more quickly acquire the initial capacity it needs to address the storm drainage issues.

Specifically, the assessment team recommends assistance to Metro Arequipa within a regional framework comprising all 19 municipalities of Metro Arequipa. This approach offers the best opportunity to build local capacity for intergovernmental and inter-stakeholder coordination; improved technical and management capacity of Metro Arequipa to design, finance, and manage adaptation strategies and programs; and linking local climate change adaptation NGOs with Municipality of Arequipa to increase the prospects for longer-term sustainability of the program.

First, direct assistance needs to be aimed at the Municipality of Arequipa, as the lead municipality in the Metro Arequipa. This assistance would help to improve intra-departmental coordination to integrate climate adaptation considerations into the municipality's policy, planning, and service operations. Second, AEDES, as a respected civil society organization that has worked intensively on sustainable development and climate change adaptation in the rural areas, will need assistance in transferring its expertise to urban climate change adaptation challenges and be able to provide training and technical advisory services to the Municipality of Arequipa. Third, working through the Municipality of Arequipa, CityLinks has preliminarily identified the need to strengthen Metro Arequipa regional organizations, such as the Association of District Municipalities of the Arequipa Province (AMDA), and the Municipal Environment Commission (Comisión Ambiental Municipal - CAM). The latter is chaired by the Municipality of Arequipa and both may serve as provincial-wide venues for facilitating key stakeholder communication and coordination of regional approaches to climate change adaptation.

The combination of these interventions would build local ownership and commitment to urban climate change adaptation action within a regional framework that encompasses Metro Arequipa, as well as provide local stakeholders with the wherewithal to undertake those actions during the life of the CityLinks program. In

addition, a successful CityLinks program could a sustainable institutional foundation for Metro Arequipa to tackle other common challenges related to climate change or in other sectors.

## 2. Introduction

Metro Arequipa is already experiencing the effects of climate change, and needs to build its climate change adaptation capacity in order to transform itself into an urban system resilient to extreme weather events, as well as to other indirect impacts of climate change.

At the request of USAID/Peru and with funding from the USAID CityLinks Leader Award, ICMA and ISC undertook a ten-day diagnostic visit to Metro Arequipa from June 18 to June 28, 2013 to assess the main climate change adaptation challenges and opportunities in Metro Arequipa. The visit consisted of 21 meetings with a diverse group of key stakeholders in the area of climate change adaptation (for meeting schedule and participating parties, please see [TABLE 1](#) in the Appendix). Participation in the meetings included national, regional, and district level government officials, international organizations, utility authorities, technical experts, and local NGOs. The purpose of these meetings was to understand the stakeholders' missions, histories, experiences, priorities, and challenges regarding the management of climate change impacts, particularly related to flooding in Metro Arequipa. The visit benefited greatly from excellent collaboration and genuine interest of the stakeholders in working closely together with CityLinks on future projects. Even though the interviewed stakeholders came from diverse institutional backgrounds, a consensus emerged on the importance of the governance system, particularly related to improving urban land-use and infrastructure planning and addressing Arequipa's current and future climate change adaptation challenges in the wake of rapid urbanization.

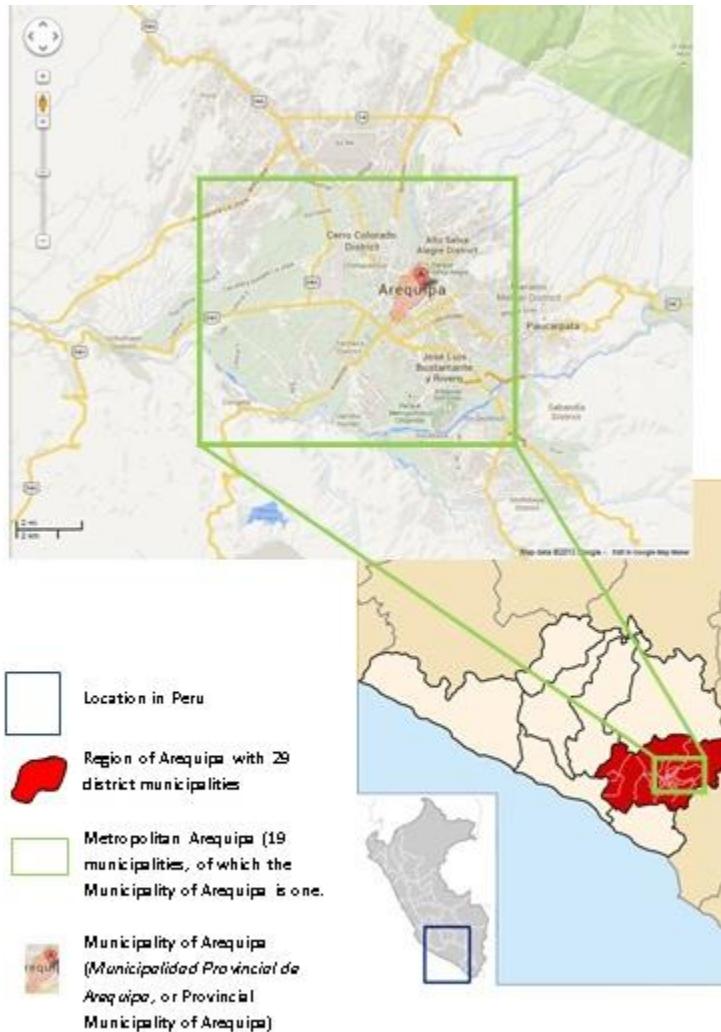
The assessment found that the major climate change patterns affecting Metro Arequipa are increased glacial melt, increased differences between maximum and minimum temperatures, increased solar radiation due to reduced cloud cover, and changing weather cycles – including reduced El Niño periods – and precipitation patterns. Together these changes are producing both direct and indirect impacts on the urban area of Arequipa, including a decreased supply of water for the urban area, hydroelectric power, food production from the surrounding region, increased pollution, negative impacts on human health, and increased intensity of storms and wind events. As the focus of the assessment is on how to improve Metro Arequipa's ability to adapt to climate change, the team reviewed the myriad contributors to climate change impacts to identify those that fall within the manageable interest of the local urban government, and in particular of the Provincial Municipality of Arequipa.

The report begins with a brief explanation of the geographic and institutional focus of the assessment (SECTION 3), followed by findings on changing climate patterns (SECTION 4.1), and the challenges and opportunities for improving governance and technical capacity to address climate adaptation challenges (SECTION 4.2). SECTION 5 outlines the major conclusions, and SECTION 6 summarizes the assessment team's major recommendations.



### 3. Geographic Focus of the Assessment: The Metropolitan Area of Arequipa

FIGURE 1 -GEOGRAPHIC LOCATION OF METROPOLITAN AREA OF AREQUIPA



The assessment focused on the geographic area of metropolitan area of Arequipa (see Figure 1), also called Metropolitan Arequipa or Metro Arequipa. The Province of Arequipa is one of 29 districts that comprise the Region of Arequipa. The province spans over a total area of 3,738 square miles, and is the second most populated province in Peru. Each district within the Province of Arequipa has its own municipal government. The Municipality of Arequipa is located in the center of the principal urban area and is one of the 19 district municipalities that make up Metro Arequipa.

Each of the 19 district municipalities operate independently, although there are institutional structures, such as the CAM (Comisión Ambiental Municipal) that serve as a coordinating mechanism for the Provincial

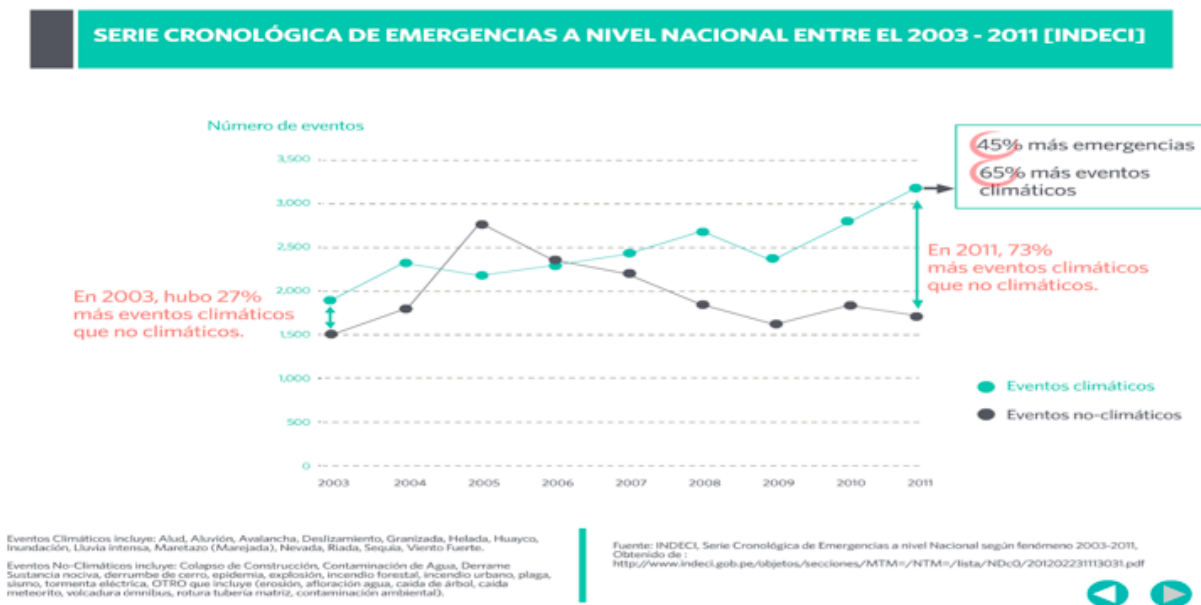
Municipality of Arequipa to coordinate actions with the other 18 district municipalities. According to the municipal government legislation, it appears that the Provincial Municipality of Arequipa regulates directly metropolitan and provincial wide matters that do not fall exclusively within a given municipality’s jurisdiction, and that each district municipality has jurisdiction over matters within their respective municipality.<sup>3</sup> Based on this law and key informant interviews, it would appear that the Provincial Municipality of Arequipa plays an important coordinating role over matters that involve decision-making by multiple district municipalities, as opposed to playing a direct management role over internal matters of the district municipalities within the province.

## 4. Findings of the Climate Change Adaption Assessment

### 4.1 Climate Change Patterns in the Region of Arequipa

The Arequipa Region is located in one of the three countries in the world, along with Honduras and Bangladesh, suffering most from climate change. Between 1993 and 2007, Peru has seen a significant increase in weather-related events, such as frost, hard rain, snow, hail and drought. By 2011, the number of weather-related emergencies by far exceeded non-climate-related emergencies (see Figure 2). While in 2003, there were only 27 percent more climate-related emergencies than non-climate-related emergencies; by 2011, Peru recorded 73 percent more climate-related emergencies than non-climate-related emergencies.

FIGURE 2- NATIONAL EMERGENCIES 2003-2011



Although comparable data is not available at the level of the Arequipa Region, the assessment team noted that in the Region of Arequipa there have been two major local climate changes over roughly the same period of time: changing minimum and maximum temperatures (see section 4.1.1), and changing precipitation patterns

<sup>3</sup> The Ley Orgánica de Municipalidades states: “Art. 6: Las municipalidades provinciales ejercen la administración municipal de su distrito y su jurisdicción se extiende al territorio de su correspondiente provincial. Las municipalidades distritales tienen jurisdicción en el territorio de su respectivo distrito...”

(see section 4.1.2). These changing climatic patterns appear to have a strong relationship to decreased agricultural production from droughts and frost in the surrounding rural areas, and increased flooding in the urban areas. As will be seen later in this report, at least in the case of urban flooding,<sup>4</sup> there are the concomitant factors of urban growth, land use changes and related governance and institutional issues that have compromised the urban drainage system and related flooding. Although it is safe to say that the unique intensity of the February 2013 storm would have overwhelmed even the best managed storm drainage system, it is also clear that the non-climatic factors associated with weak institutional and governance systems exacerbated the damages.

#### **4.1.1 Changing Maximum and Minimum Temperatures in Arequipa**

Between 1995 and 2007, the annual average temperature in the region increased by 2.6°C. Projections are that between 2010 and 2030 the Arequipa Region will experience increased temperature variability of about 1°C in the summers and 2.2°C in the winters. By 2030, variations in maximum and minimum temperatures are estimated to be close to 4°C on both ends of the scale. For Metro Arequipa and the surrounding region, these temperature changes have already led to the increased occurrence of extreme natural phenomena such as intense high wind events, droughts, cold spells, and frost, which have impacted agriculture and fishing as well as the health of the population<sup>5</sup> (see FIGURE 3).

More than 70 percent of the tropical glaciers of the world are located in Peru and are particularly vulnerable to temperature changes. It is estimated that most of the lower glaciers in the Andes could be gone within 10 years, with all the glaciers in the Andes disappearing within 20 years, and in effect drying up all glacial runoff.

The ice crust of the Coropuna glacier in the Arequipa region has decreased by 50 percent over the last 48 years.<sup>6</sup> While glacial melt initially increases runoff, the predicted disappearance of glaciers “will cause very abrupt changes in stream-flow, because of the lack of a glacial buffer in the dry season. This will affect the availability of drinking water, and of water for agriculture and hydropower production.”<sup>7</sup> A decreased water supply due to reduced seasonal runoff, may elicit the need to shift from hydropower production to other sources of energy, resulting in “large capital outlays, higher operational and maintenance costs, and—most probably—an increased reliance on fossil fuels.”<sup>8</sup> Moreover, should the glacial melt reduce water availability, one can expect to see further negative impacts on agricultural production, and potentially urban food security, and access to potable water for the urban population.

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<sup>4</sup> As the focus of the assessment was the urban flooding problem, the assessment team did not examine the climatic and non-climatic factors associated with agricultural changes in any depth.

<sup>5</sup> Global Risk Identification Program (2012). Regional Strategy for Adaptation to Climate Change in the Arequipa Region, p. 21

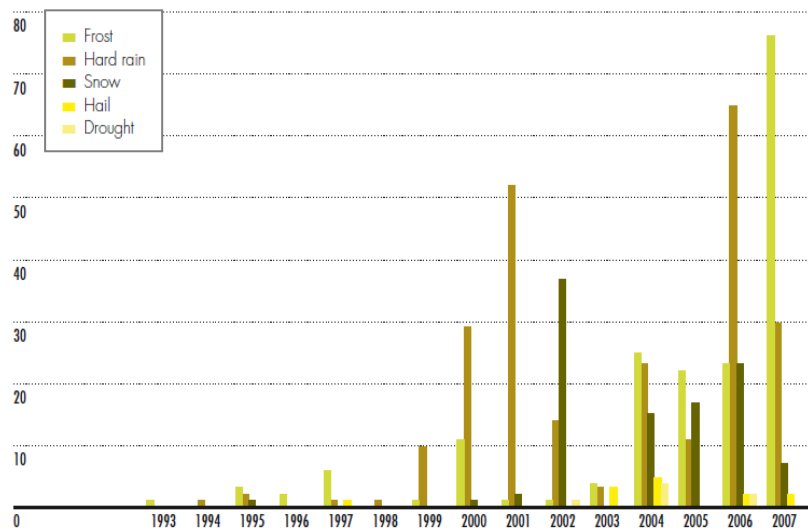
<sup>6</sup> Ibid, p. 22

<sup>7</sup> Bradley, R. S. et al. (2006). Threats to Water Supplies in the Tropical Andes. Sciences (312), p. 1755

<sup>8</sup> Ibid, p. 1756

**FIGURE 3- WEATHER EMERGENCIES IN THE REGION OF AREQUIPA, 1993 - 2007**

**Source:** Global Risk Identification Program (2012). Regional Strategy for Adaptation to Climate Change in the Arequipa Region, p. 23



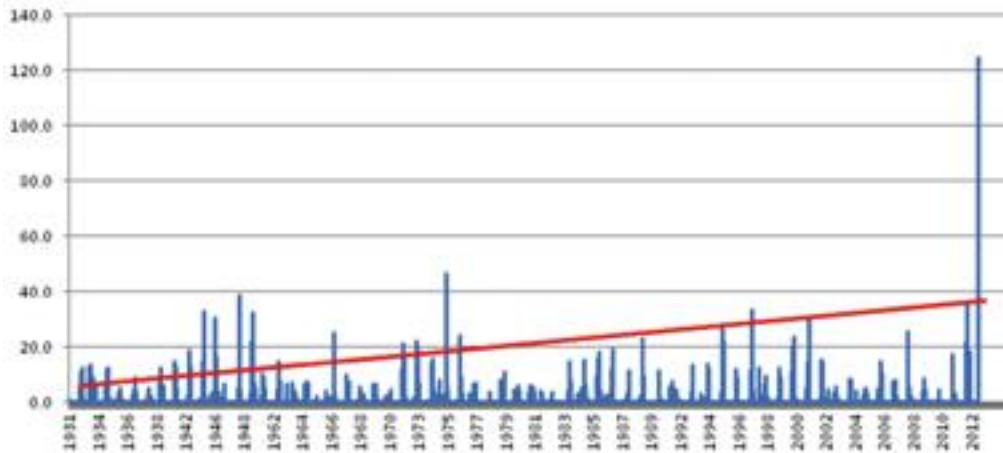
#### 4.1.2 Changing Precipitation Patterns in Arequipa

A number of interviewees noted that precipitation in the Arequipa region has become more intense and with more localized variability. Less rain has been observed in the higher watershed and more in the middle and lower watersheds of the Río Chile, the main river flowing through urban Arequipa. Historically, flash floods in Arequipa have taken place twice per decade, and now seem to be increasing in frequency. With an annual average rainfall of about 100 mm (See FIGURE 4 for historical trends), Arequipa is situated in a predominantly dry environment.<sup>9</sup> On February 8 of 2013, over 125 mm of rain fell in just four (4) hours causing six (6) deaths and over US \$37 million in property damages (see FIGURE 5). In other locales, the Region of Arequipa is facing an increase in droughts and desertification. Although the Río Chile watershed as a whole has experienced a decreased precipitation trend for the last 36 years<sup>10</sup>, there appears to be a significant increase in hard rain related emergencies during the past decade compare with the previous decade (see FIGURE 3). Should these trends continue, the Arequipa Region could likely see potentially very critical drought periods overall, while experiencing localized heavy torrential rains.

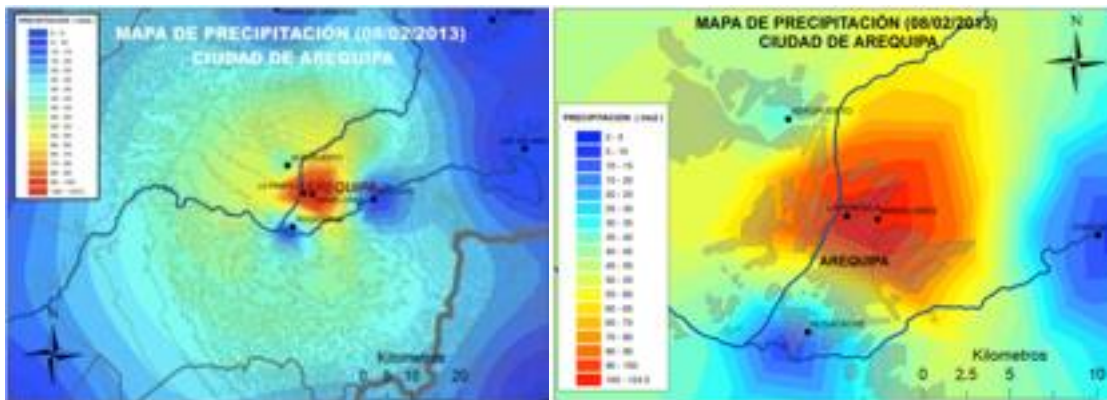
<sup>9</sup> Thouret, J.-C et al. (2013). Combining criteria for delineating lahar- and flash-flood-prone hazard and risk zones for the city of Arequipa, Peru. *Natural Hazards, Natural Hazards and Earth System Sciences* (13), p. 342

<sup>10</sup> Global Risk Identification Program (2012). *Regional Strategy for Adaptation to Climate Change in the Arequipa Region*, p. 21

**FIGURE 4- ACTUAL PRECIPITATION IN LA PAMPILLA AREQUIPA 1931-2013**



**FIGURE 5- PRECIPITATION MAP OF AREQUIPA FOR FEBRUARY 8, 2013**



## 4.2 Priority Challenges and Opportunities for Climate Change Adaptation in Arequipa

During the diagnostic visit, Metro Arequipa’s governance system (Section 4.2.1), urban infrastructure and planning (Section 4.2.2), and integrated watershed management<sup>11</sup> were identified as the three major challenges for climate change adaptation. Repeatedly during the meetings, Metro Arequipa’s rapid urbanization emerged as a crosscutting challenge, as it exacerbates the climate change impacts on the urban population due to the high stress it places on infrastructure and other urban services.

<sup>11</sup>Integrated watershed management was mentioned mostly in relation to dealing with glacial melt. Since the focus of the assessment was on urban climate change adaptation, the assessment does not deal in any depth with climatic factors affecting predominantly the rural areas or on actions, such as watershed management, which are outside the manageable interest of urban Arequipa.

In June of 2011, the Region of Arequipa had a total population of 1,245,251, representing 4.1 percent of Peru's total population. The share of Arequipa's population living in urban settings is growing (see Table 2). In 2011, 74.33 percent of the population in the Region of Arequipa lived in the Metro Arequipa, and estimates for 2013 state an urban population of 89.2 percent in the Region of Arequipa (see Appendix, [Figure 13](#)). Within the region, 75.2 percent of the population is concentrated in the Province of Arequipa. With 82.6 inhabitants per square kilometer, the Province of Arequipa has the highest population density in Peru, and is experiencing a growing demand for infrastructure and services to support its urban growth<sup>12</sup> that outstrip the local governments' ability to keep pace.

During the interviews, stakeholders pointed out that the security of services in the urban areas are a major driver of current rural-urban migration patterns. The effect of droughts on agricultural production and concomitant impacts on livelihoods may also be contributing to rural-urban migration and increased rates of urbanization in Metro Arequipa. In addition, the Asociación Especializada para el Desarrollo Sostenible (AEDES) characterized the high rates of in-migration more as a survival strategy for rural Peruvians, rather than as being driven by a pursuit of economic opportunity. This points to potential absorptive capacity issues for the urban areas to assimilate the new migrants, and related problems of urban resiliency as the new migrants may not have sufficient livelihood resources to take preventive measures or recover from climate-related disasters, such as flooding. Thus, these migration patterns are creating an influx of poor into the city, increasing the social and economic pressures on the city's governance and urban infrastructure systems, which further strain Arequipa's climate change adaptation capacity.

**TABLE 2 –**

DEVELOPMENT OF THE SHARE OF THE URBAN POPULATION IN THE AREQUIPA REGION	Year	Share of Population in	
	Total Population in the Region	Total Population in the Metropolitan Area	Metropolitan Area
	1940	263,077	46.49%
	1961	388,881	43.22%
	1972	529,566	62.66%
	1981	706,580	70.30%
	1993	916,806	73.82%
	2000	1,072,968	72.43%
	2007	1,152,303	75.00%
	2011	1,245,251	74.33%

Source: Instituto Nacional de Estadística e Informática (2011). Arequipa Compendio Estadístico Regional. Retrieved from: <http://www.inei.gob.pe/bibliotecaipub/bancopub/Est/Lib1021/libro.pdf>

### 4.2.1 Governance

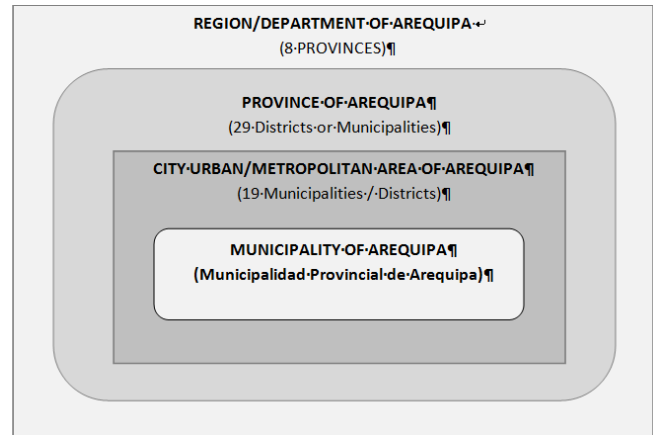
The impacts of climate change on Metro Arequipa are exacerbated by two major emerging governance challenges within the metropolitan area: a general lack of awareness of climate change adaptation issues;

<sup>12</sup> Caceres, J.A. et al. (2011). Evaluation of Demand for Sanitation Services in Peri-Urban Arequipa, Peru – 2011. UN Habitat. <http://tap.waterforpeople.org/usercontent/1/3/390630001/487/3.5.1%2B2011%2BUniversity%2BResearch%2BReport-English.pdf>

and a lack of technical and policy capacity among municipal staff to anticipate and incorporate climate change adaptation into their strategies, plans, and programs. These conditions exacerbate the climate change impacts in Arequipa and highlight a critical institutional gap, when intra-jurisdictional cooperation is required to address, for example, the drivers of urban flooding. Thus, lack of awareness across a critical mass of municipalities within the Metro Arequipa area also reduces the potential for intra-municipal cooperation and coordination among relevant stakeholders across the entire Arequipa region (SECTION 4.2.1.2).

#### 4.2.1.1 Municipality of Arequipa: Lack of Awareness and Climate Change Adaptation Capacity

While the Municipality of Arequipa is not the only actor in charge of managing the whole Metropolitan Area of Arequipa, it plays a central leadership role in the Metropolitan Area (see FIGURE 6). Therefore, the diagnostic visit focused particularly on the Municipality of Arequipa’s institutional arrangements to identify intervention points, challenges, and opportunities for improving climate change adaptation in the urban area.<sup>13 14</sup> The assessment team also explored the potential of AEDES, a civil society organization, to play a role in helping build the Municipality of Arequipa’s climate change adaptation capacity.



**FIGURE 6-LEVELS OF GOVERNMENT IN AREQUIPA REGION**

The lack of awareness of the importance of climate change adaptation is reflected in the Municipality of

Arequipa’s budget, which does not provide sufficient information to assess its commitment to climate change action. In 2012, the Municipality of Arequipa collected S/. 128.8 million (98.3 percent of its budget target). This represented 39.86 percent of the revenue raised by the Regional Government of Arequipa for the same period. The main revenue sources are the compensation municipal fund (11.33 percent), property taxation (9.58 percent), vehicle taxation (5.67 percent), and the mining fees (*canon*) (5.74 percent) (see Appendix, [Figure 7](#)). Although dependence on the *canon* is fraught with uncertainty due to inevitable fluctuations of world market commodity prices, overall revenues from Arequipa’s extractive industry have increased consistently in recent years, with the exception of 2010 (see Appendix, [Figure 8](#)) and, therefore, are expected to be a dependable revenue source for the Municipality of Arequipa in the near term.

National fiscal policy is favorable for the Municipality of Arequipa to dedicate more funding to climate change related infrastructure projects. In 2001 Peru’s national legislature passed a law requiring local governments to allocate mining revenues to infrastructure projects.<sup>15</sup> This earmarked revenue stream creates an opportunity for municipalities to address climate change adaptation measures in the context of new infrastructure investments. The municipal expenditures were only 74.75 percent of total revenues in 2012. While 35 percent of total municipal expenditures were allocated to environmental and natural disaster response programs(see Appendix, [FIGURE 9](#)), none of these funds went towards specifically designated climate change adaptation

<sup>13</sup> Please see Appendix, [FIGURE 12](#) for an Organigram of the Municipal Government of Arequipa. The departments interviewed during the diagnostic visit are highlighted.

<sup>14</sup> Insufficient time prevented the assessment team from exploring in depth the specifics of situation in the other 18 municipalities within the Metro Arequipa region.

<sup>15</sup> In Peru, the mining canon is divided among the Regional Governments (25 percent) as well as the Provincial and Municipal Governments (75 percent).



measures.<sup>16</sup> Thus, there is room for improvement within the current fiscal situation of the Municipality of Arequipa to increase funding for climate change adaptation related infrastructure.

Even though the legal framework is in place to incorporate more climate change adaptation proactive measures, laws related to climate change are de-facto not being implemented. According to a law adopted in 2011, the Subgerencia de Gestión del Riesgo de Desastres<sup>17</sup> of the Municipality of Arequipa is charged with, not only responding to disasters, but also promoting forward-looking disaster management and risk prevention measures, as well as taking other corrective actions to reduce future risks. However, the Subgerencia has not yet developed these de-jure capacities and de-facto continues to focus on its traditional civil defense activities and reactive disaster response and management activities.<sup>18</sup> Nevertheless, it may be possible to build on the existing institutional arrangements. With some reorientation, the Municipality of Arequipa could apply its resources to a more proactive disaster risk prevention and reduction program within a climate change adaptation framework. Such a strategy should also prove to be more cost effective than the current reactive strategy when one considers the relative costs of prevention and preparedness vs. the increased potential losses to flooding, for example, as urban residents increase their socio-economic status and assets values increase over time.<sup>19</sup>

Recently, the Municipality of Arequipa established a working group on disaster risk management that is led by the mayor and is comprised of the senior level department heads of the municipality (“Super Gerencia”). However, this working group has not been launched to date. Interviewees criticized capacity building efforts by the Municipality of Arequipa as too general and not focused on concrete actions to increase resilience. It became apparent during the diagnostic visit that the Municipality of Arequipa’s governance system faces a worrisome lack of awareness towards climate change impacts despite the reoccurring flooding. In addition, there is a critical need to increase the general awareness among relevant institutions and the public of the benefits of climate adaptation and urban resilience strategies, and build ownership for action among key stakeholders; something the Municipality of Arequipa has had difficulty achieving. For example, the Municipality of Arequipa’s proposed Development Plan (“Plan de Desarrollo Municipal and Territorial”) received criticism from groups, such as the Colegio de Arquitectos, for not having been developed with broad public participation and for representing business-as-usual ideas that do not address the emerging needs of the metropolitan area. Therefore, not only is it critical to build the Municipality of Arequipa’s capacity to integrate climate change as an integral part of its work on disaster risk reduction, but also to strengthen its ability to develop outreach to stakeholders and affected communities to include them in a more participatory way in the planning process.

**AEDES.** The assessment team evaluated the potential of AEDES through meetings with the NGO itself and by incorporating them into meetings with other stakeholders. Based on the interaction with AEDES and reviewing their project portfolio, AEDES appears to demonstrate the necessary knowledge and experience to identify key climate change vulnerabilities. AEDES maintains strong institutional relationships with the Regional Government and with small district municipalities of other provinces in the Region of Arequipa and shows a high potential to developing into a leading actor to help mainstream climate change adaptation needs into decision-making and policy processes throughout Metro Arequipa. So far, AEDES has worked predominantly in rural and agricultural provinces of Arequipa, and will need support to transition its expertise for building

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<sup>16</sup> Of the function environment and disaster response; 69 percent is for maintenance and conservation of green areas, 21 percent for public cleaning.

<sup>17</sup> Was formerly the Subgerencia de Defensa Civil y Nacional.

<sup>18</sup> See Appendix, [FIGURE 14](#) for the municipality’s legal statute on proactive measures.

<sup>19</sup> Kull, D., Mechler, R. and Hochrainer-Stigler, S. (2013). ‘Probabilistic cost-benefit analysis of disaster risk management in a development context.’ *Disasters*. 37(3), pp. 374-400.



climate change adaptation capacity within an urban context.<sup>20</sup> Nevertheless, AEDES is a well-respected NGO and the assessment team feels confident that AEDES, with CityLinks support, could make the transition successfully.

#### 4.2.1.2 Lack of Regional Cooperation and Coordination

A lack of cooperation and coordination among the municipal, regional and provincial governments and non-governmental organizations hinders the effective development and implementation of climate change adaptation measures in Metro Arequipa. Specific deficiencies cited during the assessment interviews on regional coordination include: (1) the lack of an adequate weather monitoring and early warning system, and (2) the failure of the Metro Arequipa to take into account its relationships to the regional ecosystem in formulating policy, plans, and programs. There did emerge, however, potential opportunities for building regional support for urban climate change adaptation, such as working through regional venues where key stakeholders could coordinate policy and actions. In this regard, the Comisión Ambiental Municipal (CAM) was identified as a potential candidate, as it operates under the auspices of the Municipality of Arequipa at the provincial level, and includes at least most of the major stakeholders.

**Weather Monitoring and Early Warning System.** The meeting with the Servicio Nacional de Meteorología e Hidrología del Perú (SNMHP) highlighted the overall lack of interest among the public and government officials in establishing an early warning system despite the increased occurrence of emergency events in the recent past. The SNMHP is installing an automated monitoring system to evaluate hydrologic resources and has faced problems resulting from overlapping efforts. They specifically criticized the construction of parallel monitoring stations by the Regional Government, and identified security concerns as equipment has been stolen and municipalities have prevented the installation of protective fences. These observations indicate a need for improved communication between SNMHP, the municipalities, and the Regional Government regarding the installation of weather monitoring and early warning system, which is a necessary step to increase Arequipa's climate change resiliency.<sup>21</sup>

**Dependency on the Region.** In contrast, stakeholders reported that there is good coordination between the Regional Government and municipal governments on a political level; however, it is mainly based on personal relationships. There is concern on the part of interviewees about the lack of coordination on a technical level. For example, the Regional Government was not consulted in the drafting of the Municipality of Arequipa's development plan, despite the municipality's interrelationship with the broader region. During a meeting, the representative of the Regional Government highlighted the necessity for increased communication with the municipality about the development plan in order to cope with emerging climate change challenges. To better deal with climate change adaptation the municipality must incorporate the link between the urban area and the surrounding ecosystems into its development plans. Recognizing that many of the Arequipa's resources come from outside the city's geo-political boundary is critical to the creation of a resilient and climate adapted urban system. This challenge demands an institutionalized forum for exchange on climate change adaptation with all relevant stakeholders.

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<sup>20</sup> In AEDES's mission statement it says: "Apoya y asesora a hombres y mujeres organizados que, valorando su cultura andina y conocimientos, para que generen una visión de desarrollo basada en los bionegocios, que les permita la adaptación y mitigación a los efectos de los cambios globales sociales y ambientales."

<sup>21</sup> The local water authority (ALA) is currently considering a novel program for Arequipa, which is called "Un Sol Para el Agua". The goal of "Un Sol Para el Agua" would be to generate funds for protecting the local watershed and improving water supply by adding one Nuevo Sol to consumer's water or electricity bill. The idea is to first start with commercial clients before expanding to all users. However, no funding has been allocated and the program is currently only under discussion.

**CAM.** The entity that shows the most promise for elevating the Municipality of Arequipa's leadership role and in bringing municipalities together on environmental issues, and shows potential for increasing cooperation around climate change adaptation is the CAM. Although the CAM has not had climate change adaptation as an explicit part of its action plan in the past, it has recently moved towards incorporating climate change adaptation into its future plans. CAM brings together all the municipalities in the Metro Arequipa area, and operates under the Subgerencia de Gestión Ambiental of the Municipality of Arequipa as authorized by a municipal ordinance. Meeting once monthly, its major streams of work are to increase green areas, improve management of protected natural areas, improve air quality, reduce noise pollution, improve solid waste management, control sewage runoff, and improve local environmental management and environmental education. Climate adaptation has now been included as an objective in CAM's Environmental Agenda 2012-2014, and the formulation of future objectives are taking place during 2013.

As the CAM incorporates climate change into its program, this will help foster a broader recognition by the Municipality of Arequipa of its dependency on the region's ecosystem, and the role that other levels of government can play as the city formulates its own policies. Once Arequipa is on board, given its strong leadership role within the region, it will be easier to convince other municipalities in the urban region to follow suit on a coordinated strategy for the implementation of effective disaster risk reduction measures, including early warning systems that take into consideration climate changes projected to affect the region. Moreover, as the Association of District Municipalities of Arequipa Province (AMDA for its Spanish acronym) is also a member of CAM, and includes in its membership all municipalities within Metro Arequipa and the Province, except the Municipality of Arequipa, AMDA will be a key stakeholder in addressing the Metro Arequipa climate change challenges.<sup>22</sup>

#### 4.2.2 Urban Land-Use and Infrastructure and Planning

In the interviews, high level municipal officials, the Local Water Authority (Autoridad Local del Agua-ALA), the Administrative Water Authority (Autoridad Administrativa del Agua -AAA) and Regional Government officials expressed the need to improve the overall urban planning capacity of the municipalities within the Metropolitan Area of Arequipa. Specifically, officials discussed vulnerabilities in the dams and storm drainage systems. Additionally, the group noted how a lack of proper urban planning has exacerbated climate change impacts and has resulted in slower economic development.

**System of Dams.** The AAA sits on the CAM, is part of the Regional Government, and has the responsibility for managing a system of dams. The dams are based in basins that feed into the Pacific Ocean and cross the Region of Arequipa and were originally built to supply water and hydroelectric power production. The representative of the AAA highlighted that the changes in precipitation patterns, however, were not anticipated when the dams were built. Today, with the shift in precipitation from the upper to the lower watershed due to climate change, the dam infrastructure no longer meets the needs of Metro Arequipa for drinking water and as a reliable source of hydroelectric power.

The Río Chile is the major river crossing through the city of Arequipa. Repeatedly during the diagnostic visit, a variety of stakeholders voiced concerns about flooding and future water scarcity across the region as a result of the misplaced dams. Dam-breaks resulting from the two-dammed lakes north of the El Misti volcano or temporary damming in the upper parts of the Río Chile can lead to flooding.<sup>23</sup> Regarding electricity generation,

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<sup>22</sup> Although the assessment team met with ADMA, it was not possible to complete a thorough evaluation of their capacity within the assessment timeframe.

<sup>23</sup> Thouret, J.-C et al. (2013). Combining criteria for delineating lahar- and flash-flood-prone hazard and risk zones for the city of Arequipa, Peru. *Arequipa Natural Hazards. Natural Hazards and Earth System Sciences* (13), p. 341

the SNMHP mentioned support for more hydroelectricity and the evaluation of the construction of a system of smaller dams as a new strategy to react to changing precipitation patterns. The ALA, which is the part of the AAA responsible for managing the Río Chile, sees these micro dams as key to adapting to climate change as the availability of snow and glacier ice as natural water “storages” during dry seasons decreases. ALA is in contact with the mayors about the construction of micro dams (100,000 m<sup>3</sup>), which are estimated to cost about \$US 40,000 each and could be administered by local communities. The ALA highlighted that a major challenge is that they need to be integrated into the Municipality of Arequipa’s land use planning to harmonize the municipality’s land use development with watershed management.

**Urban Drainage System and Lack of Planning.** The poor management of the Metro Arequipa storm drainage system and lack of regulatory enforcement are major contributing factors to the flooding problems. The main drainage canals, called *torreteras*, are located throughout many of the municipalities of Metro Arequipa. The storm drainage system serves both high and low-income parts of the urban population. For most of the year the *torreteras* do not carry water, but their role becomes crucial during high intensity rain events (see IMAGE 1). Parts of Metro Arequipa are located on the slopes of the active volcano El Misti, which has produced ash and other volcanic material in the past (see Appendix, [FIGURE 10](#)). During sudden rainfall these materials from El Misti mix into muddy flash floods that run through the *torreteras* in Metro Arequipa, exacerbating the flood risks.<sup>24</sup> During the visit the assessment team was able to personally inspect the condition of the *torreteras*. Rapid urbanization, uncontrolled housing structures in close proximity to the *torreteras* and on the slopes of El Misti, and a lack of maintenance have led to a situation in which the *torreteras* are filled with garbage and construction rubbish, which impede the drainage of runoff during heavy rains. In addition to the *torreteras*, large drainage canals have been put in place by commercial construction projects, such as shopping malls. These “drainage highways” present a high risk to the population as they turn into enormously forceful water streams that overflow during heavy rains.

**IMAGE 1 –**  
TORRETERAS IN  
AREQUIPA



Risk maps for Metro Arequipa (Thouret et al. 2013) show the overlap of areas at high risk of flooding and areas predominantly inhabited by socio- economically disadvantaged segments of the population (see Appendix, [Figure 15](#) and [Figure 16](#) ).<sup>25</sup> Among this population are new migrants from rural areas that settled in unauthorized peri-urban outskirts of Metro Arequipa. These settlements and their residents are highly vulnerable to natural hazards, having limited access to vital resources (hospitals, drinking water, fire stations,

<sup>24</sup> Enjolras, G. et al. (2011). Managing flood hazards and risk in a changing climate: The Indonesian and Peruvian experiences. World Congress on Water, Climate and Energy, p.6

<sup>25</sup> Thouret, J.-C et al. (2013). Combining criteria for delineating lahar- and flash-flood-prone hazard and risk zones for the city of Arequipa, Peru Arequipa Natural Hazards. Natural Hazards and Earth System Sciences (13), p. 339

and safe areas such as parks to where they can evacuate).<sup>26</sup> Thus, the entire population of Metro Arequipa is either directly or indirectly impacted by flashfloods.<sup>27</sup> During the meeting with the Municipality of Arequipa, officials highlighted the fact that about 70 percent of the buildings in the municipality do not meet minimal construction standards. In addition to unplanned residential settlements, speculative private sector infrastructure development has produced uncoordinated projects, such as the construction of apartment complexes built with no links to public transportation and commercial centers built close to the *torreteras*. While the Municipality of Arequipa has developed maps outlining hazardous zones, these maps are not available to the public. Soon after a flooding event in 2011, people quickly reoccupied flooded areas in spite of the risks of future flooding and loss of life and property.<sup>28</sup>

Urbanization has played an important part in improving the socio-economic status of Metro Arequipa residents. Nevertheless, the uncontrolled development accompanying urbanization may, if left uncorrected, diminish these positive economic benefits. As the second largest Peruvian city, Metro Arequipa is one of the country's commercial and tourism centers.<sup>29</sup> From 2002 to 2012 the GDP of Peru grew by 6.4 percent; at the same time, the regional GDP of Arequipa grew by 6.7 percent (see Appendix, [FIGURE 11](#)).<sup>30</sup> The disruption of critical infrastructure and thus critical services by severe flooding in the Metro Arequipa negatively impacts overall economic activity as well as the workforce itself, since commercial infrastructure is often located near the *torreteras*. Cascading reductions in services and economic output result when key industries, such as transportation, mining, agriculture, and electricity suffer reduced or interrupted production for extended periods of time.

Hence, changes in precipitation patterns combined with unregulated housing developments, poor management of the storm drainage system, and an ill-designed and poorly managed dam system, when taking place in a context of accelerating urbanization, are all contributing to the challenges of climate change adaptation in Metro Arequipa; thus, exposing a growing portion of the region's urban population and urban assets to flooding hazards. This situation has both direct and indirect impacts on the lives of the Metro Arequipa residents, as well as on their economic activities during heavy rain events. In order to reduce the risks resulting from residential as well as commercial development in vulnerable areas, the Metro Arequipa's capacity to integrated climate change adaptation into urban planning and infrastructure development needs to be improved. The drains need to be cleaned, their usage needs to be regulated, and early warning measures need to be implemented in order for the urban population to be prepared in a timely manner before heavy rains take place.

## 5. Conclusion

Although the assessment scope and length did not permit collection and analysis of data at the Metro Arequipa level to make more definitive statements about cause and effect relationships and fully map out the institutional and inter-institutional processes and challenges, the assessment team learned sufficient information that points to changes that are needed to ameliorate the climate change impacts that appear to be the major causes of the flooding. Unless corrected, Metro Arequipa can be expected to continue to suffer

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<sup>26</sup> Ibid, p. 339

<sup>27</sup> Ibid, p. 343

<sup>28</sup> Enjolras, G. et al. (2011). Managing flood hazards and risk in a changing climate: The Indonesian and Peruvian experiences. World Congress on Water, Climate and Energy.

<sup>29</sup> Thouret, J.-C et al. (2013). Combining criteria for delineating lahar- and flash-flood-prone hazard and risk zones for the city of Arequipa, Peru. Natural Hazards and Earth System Sciences (13), p. 341

<sup>30</sup> The Region of Arequipa contributes five (5) percent to Peru's GDP with a local economy depending on manufacturing (18.3 percent), services (16.7 percent), commerce (14.7 percent), and agriculture (12.4 percent) (see Appendix, [TABLE 3](#)).

increasing losses of life and property due to weather-related events. Metro Arequipa needs to become more proactive and forward looking by integrating climate-related vulnerabilities and risks into its land use and infrastructure service planning, taking into consideration projected urban population growth and settlement patterns, and potential shifts in frequency and severity of weather-induced disasters due to climate change.

From among the range of potential direct and indirect climate change risks facing Metro Arequipa, it was necessary to focus on a small set of priorities that could help bring near-term improvements in Metro Arequipa's climate change adaptation capacity. Issues such as glacial melt and the impact on the dam system require actions that are too removed from the purview of urban Arequipa's manageable interest. Other issues, such as reduction in greenhouse gas emissions and other pollutants, while important, are climate mitigation measures that could be address in the context of urban Arequipa, but were outside the scope of the current of assessment, with its focus on adaptation. Thus, the team identified the flooding hazard as a priority that Metro Arequipa needs to address, and is feasible to significantly make progress on over the next three-to-five years.

Improving the Metro Arequipa adaptation capacity for climate change related to urban flooding is dependent on improving the technical and leadership capacity of the Municipality of Arequipa, both to bolster intra-municipal coordination and planning, as well as to strengthen the municipality's leadership role within the Metro Arequipa area. Although there are a myriad of climate change issues facing Metro Arequipa, one of the most critical and one which is the most feasible to address over the next several years is the acute flooding problem. The most promising avenue for this work is to build on the growing awareness of the devastating floods and the prospect for their increased frequency, and integrate the disaster risk reduction focus of Metro Arequipa within a metropolitan-wide climate change adaptation strategy focused primarily on reducing the destructive impacts of urban flooding. Success in this arena could be the basis for addressing later other issues, such as dam system management, or the urban food security systems. Finally, the assessment team believes that working to build the Municipality of Arequipa's capacity through AEDES will go a long way towards creating the local capacity to continue to support the Municipality of Arequipa's leadership role within the Metro Arequipa area and its work towards a collaborative and integrated climate change adaptation strategy.

## **6. Recommendations for Climate Change Adaptation in Arequipa**

To improve Metro Arequipa's capacity to confront the challenges of climate change, the assessment team recommends an approach that builds on local institutional capacity to bolster the leadership role of the Municipality of Arequipa within a regional Metro Arequipa framework. Preliminary thinking on this approach would involve developing AEDES as a provider of capacity building services to the Municipality of Arequipa. The objective would be to improve the intra-municipal capacity for conducting vulnerability and institutional assessments related to the flooding problems within Metro Arequipa, most likely working through the CAM. This approach would require the Municipality of Arequipa to gain better understanding of how disaster risk reduction would operate within a climate change adaptation framework, including better capacity for scenario planning, cost-benefit analysis of disaster risk management options, outreach and involvement of key stakeholders, and leveraging the municipality's leadership role within the Metro Arequipa area through CAM to enhance intra-municipal collaboration on these issues.

The objective behind the combination of these activities is to build local ownership and commitment to climate change adaptation action, and provide local stakeholders with the ability to undertake those actions during the life of the CityLinks program, while laying the foundation for a longer-term assistance program that could go beyond the direct impacts to begin to assess and address the more indirect impacts on vulnerable populations within Metro Arequipa. This approach offers the best opportunity to build local capacity for intergovernmental

and inter-stakeholder coordination and improved technical and management capacity of the Municipality of Arequipa to design, finance, and manage adaptation strategies and programs. We anticipate that this increased capacity at the within the Municipality of Arequipa will help in turn improve capacity of Metro Arequipa. Linking AEDES local climate adaptation expertise with Arequipa will increase the prospects for longer-term sustainability of the program. ICMA's CityLinks program is uniquely positioned to support USAID's efforts through its time tested city-to-city partnerships, and capacity building efforts that strengthen local organizations to serve as support to the local governments.

## 6.1 Assistance to the Municipality of Arequipa

Firstly, as the lead municipal government within the region, direct assistance needs to be aimed at the Municipality of Arequipa to improve intra-departmental coordination to better integrate climate adaptation considerations into the municipality's policy, planning, and service operations. The resiliency of urban infrastructure and the security of the urban population depend highly on urban planning that anticipates the risks resulting from climate change impacts. Although planning for climate change adaptation is a fairly new task for urban planners and managers, making the adoption of plans for adaptation an innovative practice in urban management challenging,<sup>31</sup> there are many examples of innovative plans and strategies developed by US cities and other cities in developing countries, which can serve as models for Arequipa. For example, Metro Arequipa's urban planners need to avoid residential and commercial construction in high-risk areas of the drainage system, and ensure the cleaning and maintenance of the drains in order to secure their proper functioning during intensive rain events. Success in these endeavors will require cooperation among the municipalities through which the storm drain system crisscrosses. Southeast Florida, under the leadership of Fort Lauderdale, developed a regional compact among its constituent cities and counties to address climate change adaptation challenges.

Initially, CityLinks could build the local capacity that would allow the Subgerencia de Gestión del Riesgo de Desastres of the Municipality of Arequipa to improve its ability to integrate climate change adaptation into its disaster risk reduction and preparedness program with a focus on improving management of the storm-drainage system. Melding this system into a shared objective for both disaster risk management and climate change adaptation will improve adaptation capacity as they together create a synergy designed to decrease vulnerability to hazards of climate change effects.<sup>32</sup> Improving the storm drainage system would also require Metro Arequipa to develop a better capacity to work with diverse stakeholders within and across municipalities in the region, as well as with different levels of government to forge a coherent approach to improving the storm drainage system. ICMA, through past projects, has found that peer learning has been an effective way to build this type of capacity across diverse stakeholders and decision makers. Peer exchanges facilitated through CityLinks combined with direct technical assistance and training could help Metro Arequipa more quickly acquire this initial capacity. Specifically, the assessment team recommends the use of city-to-city exchanges with U.S. or third country cities that have confronted similar practical problems as those facing Metro Arequipa. CityLinks has access to a rich resource network of local government officials in the US and in developing countries for such exchanges to tailor a program to fit the unique circumstances of Arequipa.

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<sup>31</sup> Johnson, K. and Breil, M. (2012). Conceptualizing urban adaptation to climate change. Findings from an applied adaptation assessment framework. Centro Euro-Mediterraneo per i Cambiamenti Climatici, p. 5

<sup>32</sup> Ibid, p. 17

## **6.2 Assistance to AEDES on Urban Climate Change Adaptation**

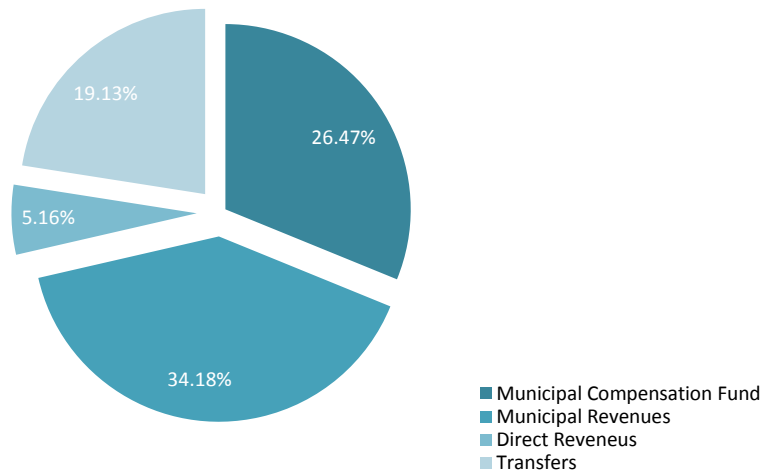
Secondly, ICMA proposes to help AEDES develop the capacity to provide services and guidance to the Municipality of Arequipa (and eventually other local and regional governments) in urban climate change adaptation. By embedding an advisor in AEDES, CityLinks could help the organization translate its climate change expertise to fit urban Arequipa's needs. AEDES could serve as the local training and technical assistance arm of ICMA for this project and inter alia undertake the organization of much of the locally-based training and technical assistance to the various stakeholders, especially to the Municipality of Arequipa. AEDES would also participate in the exchanges with US or third country cities and NGOs involved with local governments in climate adaptation strategies and actions.

## **6.3 Strengthening Regional Cooperation in the Scope of the CAM**

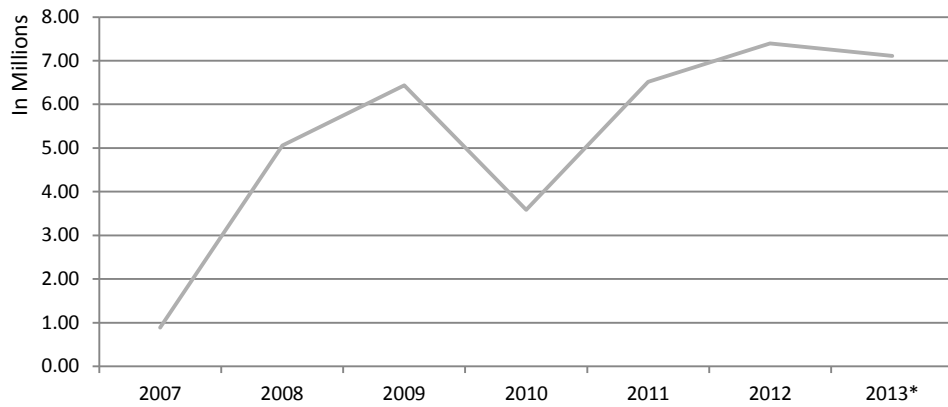
Thirdly, we have preliminarily identified the need to strengthen the CAM, which we believe is an organization with good outreach and, thus, well positioned to facilitate increased communication and coordination of climate adaptation efforts among all stakeholders. The CAM added the creation of a working group on climate adaptation as an objective in their Environmental Agenda 2012-2014. As the CAM is formulating additional objectives during 2013, a window of opportunity has opened to include further climate change adaptation activities. Due to the interdependency of the region and the municipalities within the urban area, improving the coordination and cooperation between relevant stakeholders is a necessity in order to guarantee the effectiveness of climate change adaptation measures for the entire Metropolitan Area of Arequipa. As the CAM operates under the authority of the Provincial Municipality of Arequipa and brings together the district municipalities, as well as regional stakeholders such as AAA, it demonstrates an ideal focal point to streamline climate change adaptation efforts. Moreover, success in creating an effective coordinating mechanism at the metropolitan level could provide a springboard for the 19 municipalities in the Arequipa metropolitan area to begin to address other environmental and climate change challenges beyond the flooding hazard. During project design, CityLinks would assess the feasibility of selected assistance to members of CAM, such as ADMA, AAA, or ALA, depending on whether such assistance would contribute to ensuring project success.

## Appendix

**FIGURE 7-** BUDGET REVENUES 2012 MUNICIPAL GOVERNMENT OF AREQUIPA



**FIGURE 8-** MINING CANON REVENUES OF THE MUNICIPAL GOVERNMENT OF AREQUIPA 2007-2013





**FIGURE 9- CLASSIFICATION OF EXPENDITURES OF THE MUNICIPAL GOVERNMENT OF AREQUIPA 2012**

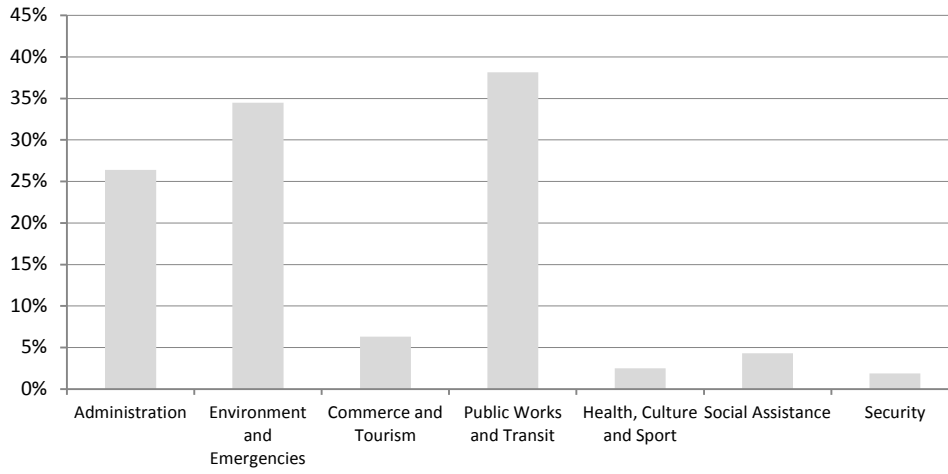


FIGURE 10-MAP OF THE AREQUIPA REGION

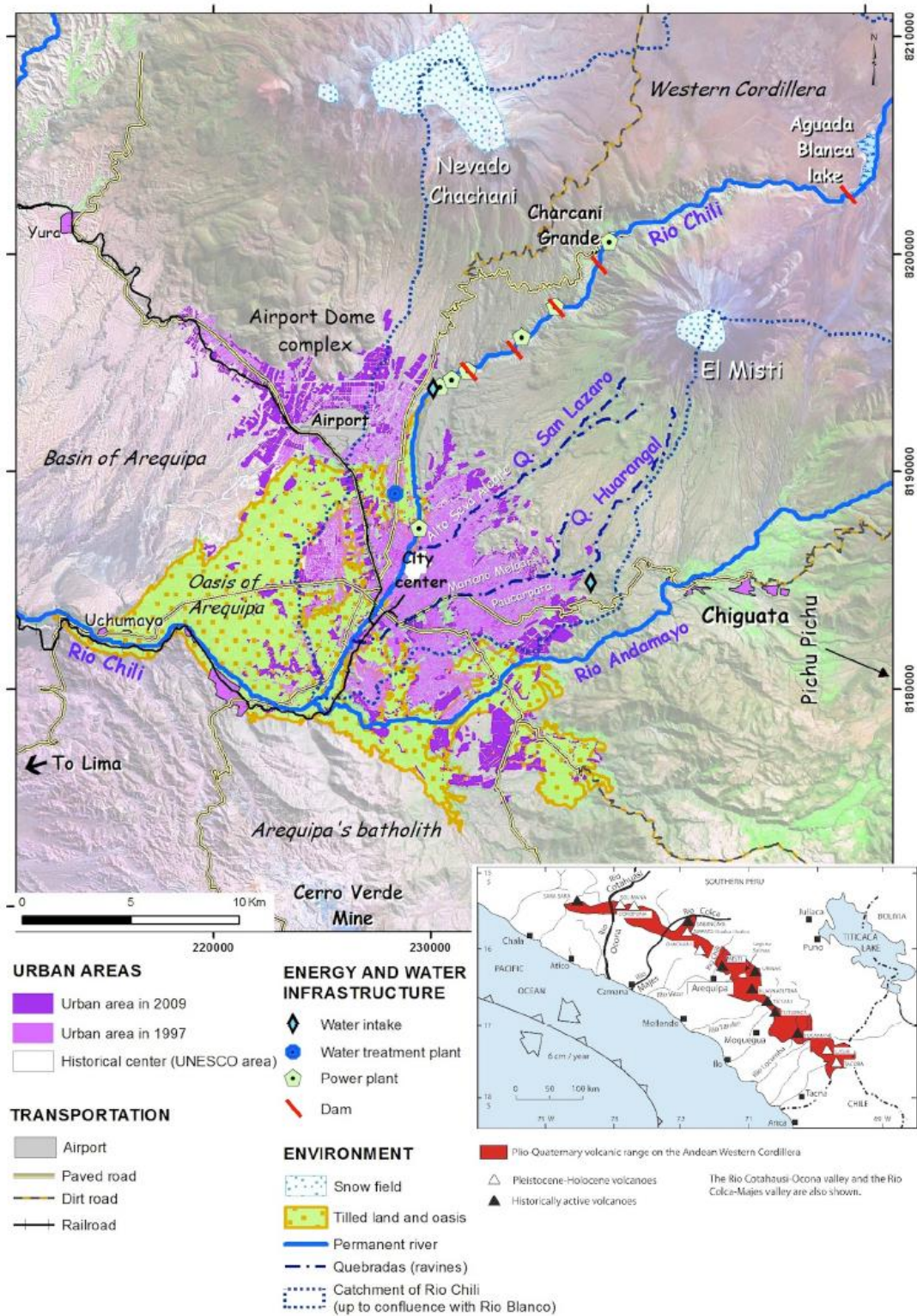


FIGURE 11- GDP PERU AND REGION OF AREQUIPA



FIGURE 12- ORGANOGRAM MUNICIPAL GOVERNMENT OF AREQUIPA

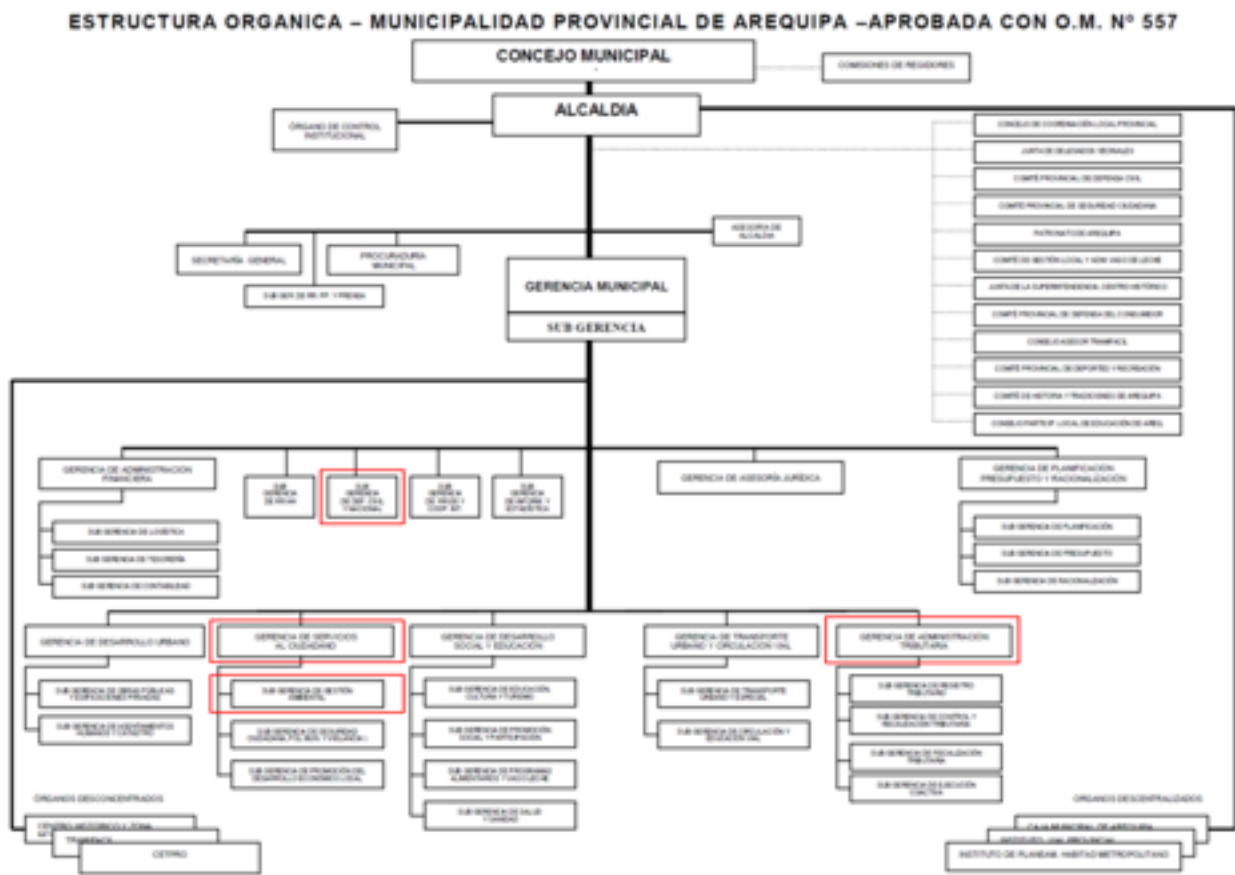
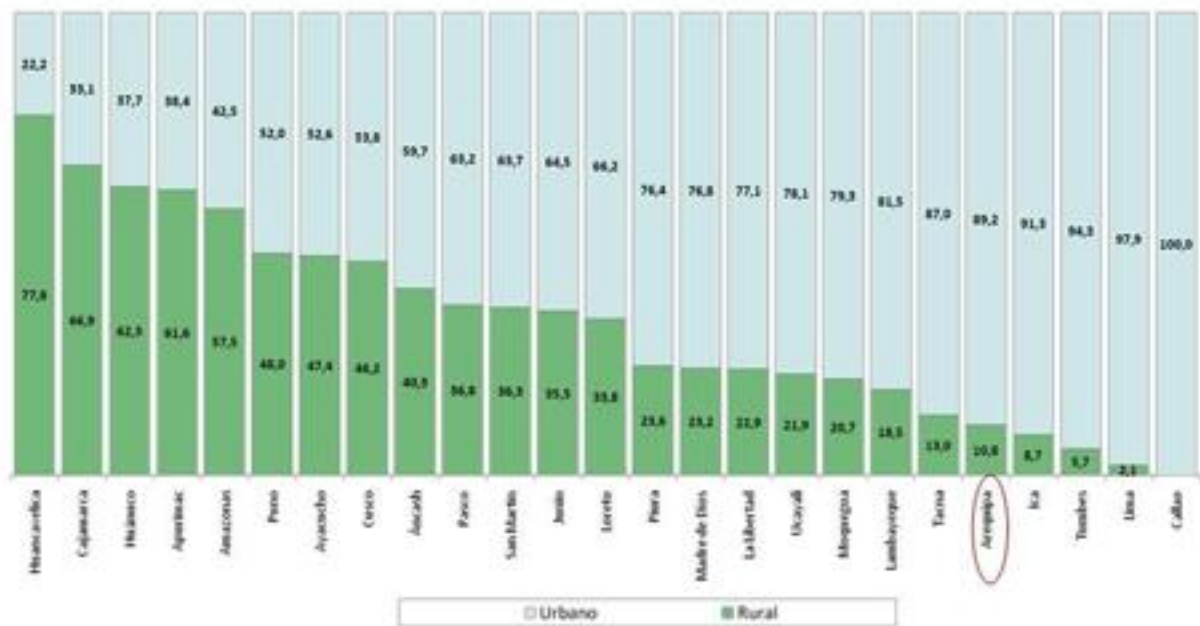


FIGURE 13-PROJECTIONS 2013 URBAN POPULATION IN DEPARTMENTS OF PERU



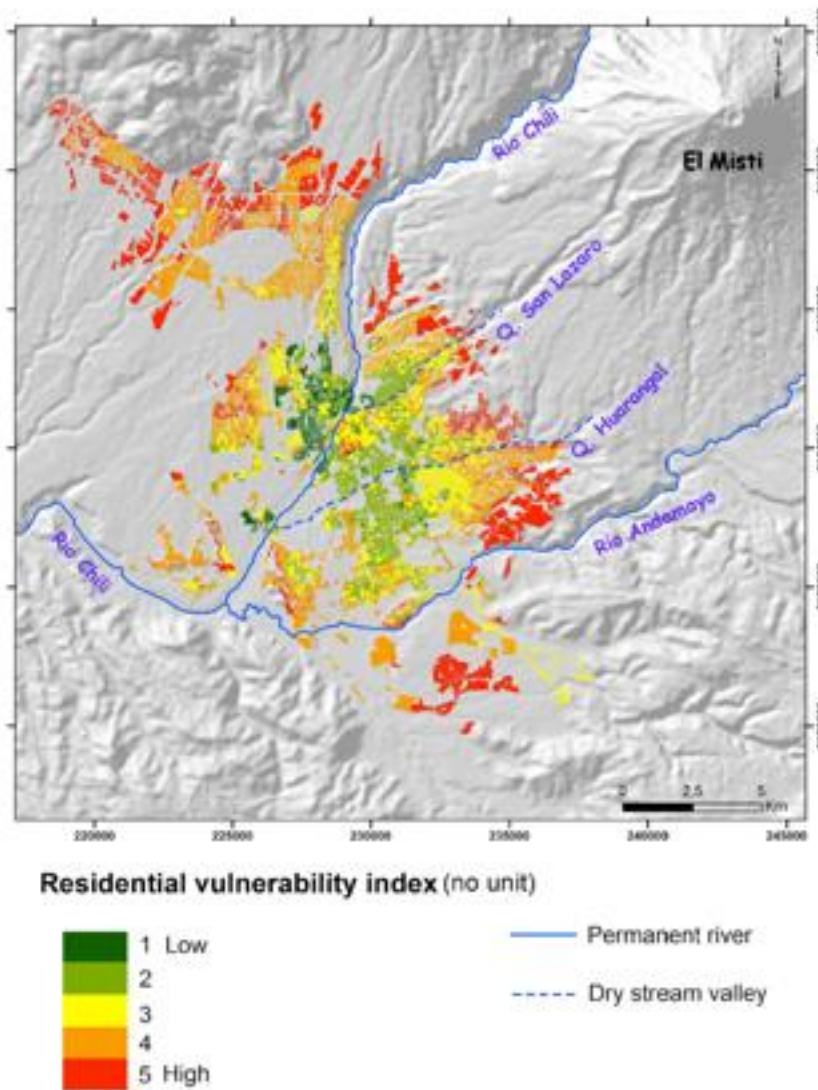
Fuente: Instituto Nacional de Estadística e Informática (INEI) –  
 Perú: Estimaciones y Proyecciones de la Población por Departamento, Sexo y Grupos Quinquenales de Edad, 1995-2025.



FIGURE 14- ORDENAZA MUNICIPAL NO. 728

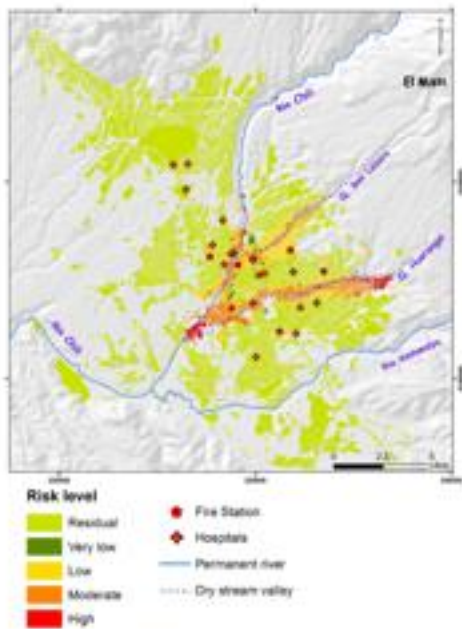


**Figure 15-** MAP OF RESIDENTIAL VULNERABILITY TO NATURAL HAZARDS OF THE CITY OF AREQUIPA

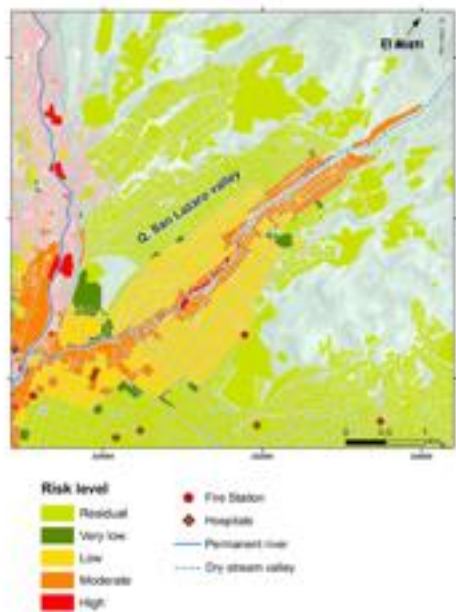


**Source:** Thouret, J.-C. et al. (2013). Combining criteria for delineating lahar- and flash-flood-prone hazard and risk zones for the city of Arequipa, Peru. *Natural Hazards and Earth System Sciences* (13), p. 350

**FIGURE 16-** MAPS OF RISK LEVEL, ISOLATION, AND VULNERABILITY TO NATURAL HAZARDS OF THE CITY OF AREQUIPA

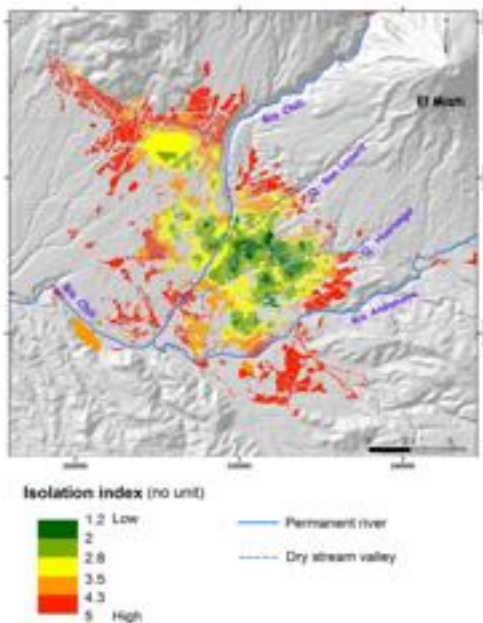


**Fig. 13.** Areas prone to lahar and flood risk in Arequipa. Areas prone to lahar and flood risk have been divided into five classes according to Table 8 (LRL). The scale of original data (city block) ensures a high level of precision. The figure takes into account flood and lahar risk only; hence only the river and Quebrada channels are at risk.

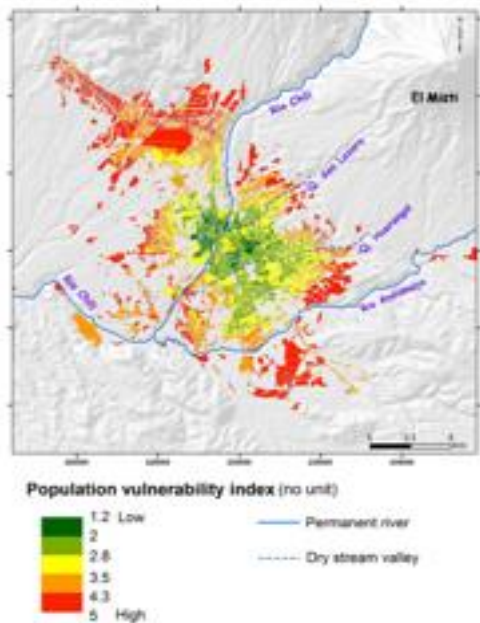


**Fig. 14.** Areas prone to lahar risk in the Quebrada San Lazaro; this map is an enlargement of Fig. 13.

poorly built and do not have any access to basic facilities in the case of an emergency.



**Fig. 11.** Map showing the combined "isolation" of the population in Arequipa. The overall isolation index (II) comprises five classes (see Table 6a). The map takes into account road conditions (Table 6b). The scale of original data (city block) results in a high level of precision.



**Fig. 12.** Map of the overall population vulnerability in Arequipa. The overall vulnerability index comprises five classes according to Table 7 (PvI). The scale of original data (city block) results in a high level of precision.

Source: Thouret, J.-C et al. (2013). Combining criteria for delineating lahar- and flash-flood-prone hazard and risk zones for the city of Arequipa, Peru. *Natural Hazards and Earth System Sciences* (13), p. 350

TABLE 1: TIMELINE AND PARTICIPANTS IN MEETINGS

#	Date & Time	Organization and Participants	#	Date & Time	Organization and Participants
1	June 18, 2013 9:00 - 9:30	<b>USAID Peru:</b> Mr. Jeremy Boley, Acting Deputy Office Chief, Office of Economic Growth and Environment (EGE) and Mr. Fernando Chaves, EGE  <b>ISC:</b> Mr. Scott Muller, Sr. Manager International Climate Programs	6	June 19, 2013 14:30 - 15:45	<b>Autoridad Regional Ambiental del Gobierno Regional de Arequipa (ARMA):</b> Mr. Anibal Díaz Robles, Manager and Mr. Gustavo Delgado Alvarado, Project Coordinator, Economic and Ecologic Zoning for the Region of Arequipa  <b>UNDP:</b> Mr. Michael J. Alfaro Gómez, Project Coordinator (Support for the Recuperation Process in the Region of Arequipa)
2	June 18, 2013 10:30 - 12:00	<b>Centro Nacional de Estimación, Prevención y Reducción del Riesgo de Desastres (CENEPRED):</b> Ms. Melva González Rodríguez, Chief and Ms. M. De Guadalupe Masana García, Director of Risk Management Processes.  <b>USAID Peru:</b> F. Chaves; <b>ISC:</b> S. Muller			<b>USAID Peru:</b> F. Chaves  <b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado, <b>AEDES:</b> Felio Calderon
3	June 18, 2013 15:00 - 17:00	<b>Ministerio de Ambiente (MINAM):</b> Mr. Eduardo Durand López-Hurtado, Director General of Climate Change, Desertification and Hydrologic Resources, Ms. Claudia Figallo and Ms. Laura Avellaneda. Visit from Mr. Gabriel Quijandría, Vice Minister  <b>USAID Peru:</b> F. Chaves  <b>ISC:</b> S. Muller	7	June 19, 2013 16:00 - 17:00	<b>Gobierno Regional de Arequipa:</b> Dr. Juan Manuel Guillén Benavides - President. A Díaz Robles.  <b>UNDP:</b> Mr. Michael J. Alfaro Gómez  <b>USAID Peru:</b> F. Chaves  <b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado; <b>AEDES:</b> Felio Calderon
4	June 19, 2013 10:00 - 10:30	<b>Municipalidad Provincial de Arequipa:</b> Dr. Alfredo Zegarra Tejada, Mayor of the Provincial Municipality of Arequipa and Mr. Jorge Luis Nuñez, Manager of City Services.  <b>USAID Peru:</b> F. Chaves  <b>ICMA:</b> Carlos Loria Chaves, Economic and Governance Advisor; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado, Consultant to ICMA	8	June 19, 2013 19:00 - 21:00	<b>Colegio de Arquitectos:</b> Ms. Evelia Medrano Guevara, Member of the Evaluating Committee of the Territorial and Metropolitan Development Plan of Arequipa  <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado
5	11:00 - 12:00	<b>Asociación de Municipalidades Distritales de la Provincia de Arequipa:</b> Mr. Omar Candia Aguilar, Mayor of the District of Alto Selva Alegre and President of the Association of Mayors.  <b>USAID Peru:</b> F. Chaves  <b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller;	9	11:00 - 12:30	<b>Autoridad Administrativa del Agua (AAA):</b> Mr. Ronal Fernández Bravo, Director, Capilina - Ocoña Watersheds  <b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado



		<b>PREDES:</b> Felipe Parado	10	<b>June 20 2013</b>	<b>Proyecto Especial Cooperación con el Proceso de Autodesarrollo Sostenible en Arequipa (COPASA):</b> Mr. Jorge Lira Torres
		<b>Asociación Especializada para el Desarrollo Sostenible (AEDES):</b> Mr. Felio Calderon, Program Manager.		15:00 - 16:30	<b>UNDP:</b> M Alfaro Gómez
11	<b>June 20 2013</b>	<b>AEDES:</b> Roberto Zegarra Balcázar, Executive Director, F Calderon, Mr. Teofilo Condori Vilca, Planificación y Monitoreo.	17	<b>June 25, 2013</b>	<b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado <b>LABOR NGO:</b> Mr. Denis Rojas, Project Coordinator, Adaptation and Mitigation of Climate Change in the Coastal Zone
	17:00 - 19:00	<b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado		8:30 - 12:00	<b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado
12	<b>June 21, 2013</b>	<b>Subgerencia de Gestión del Riesgo de Desastres de la Municipalidad Provincial de Arequipa:</b> Ms. Isabel Hinojosa Reynoso, Architect	18	<b>June 25, 2013</b>	<b>Autoridad Autónoma del Majes (AUTODEMA):</b> Mr. Ramiro Armas Mendoza, Vice Director of Operations and Maintenance and Ms. Ana Lucía Paz Alcazar
	8:30 - 12:00	<b>Oficina de Defensa Civil de la Municipalidad Distrital de Alto Selva Alegre:</b> Mr. Henry Pareja Rodríguez		14:00 - 16:00	<b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado
		Centro de Estudios y Prevención de Desastres: Ms. Roxana Amache Cutipa.			
		<b>ISC:</b> S Muller			
13	<b>June 21, 2013</b>	<b>Gerencia de Planificación, Presupuesto y Racionalización de la Municipalidad Provincial de Arequipa:</b> Mr. Manuel Huamanvilca Huarca, Manager and Ms. Carmen Delia Vasquez Valdivia	19	<b>June 26, 2013</b>	<b>Subgerencia de Gestión Ambiental de la Municipalidad Provincial de Arequipa:</b> J Rosas Ramos, Mr. Giovanni Salas Medina and Ms. Sandra Torres Chaves.
	9:30 - 11:00	<b>ICMA:</b> Carlos Loria Chaves; <b>PREDES:</b> Felipe Parado		8:30 - 12:00	<b>ICMA:</b> Carlos Loria Chaves; <b>PREDES:</b> Felipe Parado
14	<b>June 21, 2013</b>	<b>Gobierno Regional de Arequipa:</b> Mr. Carlos Leyton Muñoz, Chief Advisor to the President	20	<b>June 26, 2013</b>	<b>Subgerencia de Gestión del Riesgo de Desastres de la Municipalidad Provincial de Arequipa:</b> J. Vasquez, Ms. Isabel Hinojosa Reynoso, Mr. Felipe Pocco Huamaní, Subgerente de Racionalización de la Municipalidad Provincial de Arequipa
	15:30 - 16:30	<b>UNDP:</b> M Alfaro Gómez		14:30 - 16:30	<b>ICMA:</b> Carlos Loria Chaves; <b>PREDES:</b> Felipe Parado
		<b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado			

15	<b>June 24, 2013</b>  8:00 - 9:00	<b>Servicio Nacional de Meteorología e Hidrología del Perú (SENAMHI):</b> Mr. Sebastián Zúñiga Medina, Regional Director  <b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado	21	<b>June 28, 2013</b>  12:00 - 13:30	<b>USAID Peru:</b> Mr. Joseph Ryan, J Boley, F Chaves.  <b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado
16	<b>June 24, 2013</b>  9:00 - 11:00	<b>Gerencia de Servicios al Ciudadano de la Municipalidad Provincial de Arequipa:</b> J Luiz Nuñez, Manager and Mr. José Vasquez Allasi, Manager of Subdepartment of Risk Management and Mr. Jorge Rosas Ramos, Manager of Subdepartment of Environment  <b>ICMA:</b> Carlos Loria Chaves; <b>ISC:</b> S. Muller; <b>PREDES:</b> Felipe Parado	21	<b>July 29</b>	<b>End of Diagnostic Visit</b>

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**TABLE 3: ECONOMIC GROWTH BY SECTOR IN THE REGION OF AREQUIPA**


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<b>Sector</b>	<b>Percentage Share of Economy</b>	<b>of Average Annual Growth 2002-2011</b>
Agriculture, Hunting, Forestry	12.4%	4.9%
Fishery	0.3%	0.5%
Mining	9.4%	11.7%
Manufacturing	18.3%	6.5%
Electricity and Water	1.6%	1.7%
Construction	10.9%	13.7%
Commerce	14.7%	5.2%
Transport and Communications	8.6%	6.6%
Restaurants and Hotels	2.9%	6.4%
Governmental Services	4.2%	6.9%
Other Services	16.7%	5.4%
<b>Total Additional Value</b>	<b>100.0%</b>	<b>6.7%</b>

Source: INEI – Sistema de Información Regional Para La Toma De Decisiones (SIRTOD), <http://webinei.inei.gob.pe/SIRTOD/#app=5e8f&5415-selectedIndex=1&61dd-selectedIndex=1>