

Disaster Risk Management in Water and Sanitation

# **Economic impact of the 2007 earthquake in the water and sanitation sector in four provinces of Peru**

**What did unpreparedness cost the country?**

May 2011

## **Economic Impact of the 2007 Earthquake in Peru in the Water and Sanitation Sector**

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## I. INTRODUCTION

Between 1996 and 2005, natural catastrophic events had an estimated cost of US\$575.2 billion world-wide<sup>1</sup>. In particular, it has been observed that developing countries are relatively more affected by such events, since its GDP have showed sharper declines than developed countries's ratios<sup>2</sup>.

On August 15, 2007, an earthquake measuring 7.9 on the Richter scale shook the southern part of the central coast of Peru, with devastating consequences. Given the magnitude of the damage caused, one wonders how much less the cost of rehabilitating water and sanitation systems might have been if public investment projects and management of urban utilities (companies in charge of the water and sanitation provision), had incorporated disaster risk reduction measures. For this reason, and because this is a key public sector service for the wellbeing of population, the World Bank's Water and Sanitation Program commissioned Apoyo Consultoria S.A.C. to conduct a research on the water and sanitation sector in order to attend the following inquiry: *How much unpreparedness cost to the sector providing water and sanitation services? In other words, in economic terms, what would have been the gain to society or the reconstruction savings if risk prevention measures had been included in the management of services in the sector proposed for the analysis?*

In answer to this question, the study estimated how much was spent on making this very important sector operational again and restoring it to the levels existing prior to the earthquake: in other words, what were the direct effects. Using this figure, it has been calculated how much would have been saved in achieving sector recovery if appropriate work had previously been done to maintain infrastructure and if the infrastructure had been constructed using earthquake-resistant materials. It has also been calculated how much revenue the *enterprises providing water and sanitation services* lost after the earthquake. In other words, what were the indirect effects, specifically, in the urban areas where the following service providers operate: EMAPICA (Ica), EMAPISCO (Pisco), SEMAPACH (Chincha) and EMAPA Cañete (Cañete).

1 Hofman, David. "Time to Master Disaster", *Finance and Development Magazine*, volume 44, number 1, March 2007.

2 In this connection, in the World Bank discussion paper entitled "Complementing Natural Disasters Management: The Role of Social Protection", Renos Vaki states that, after Hurricane Mitch in 1998, the GDP of Honduras was six percentage points below pre-disaster projections. The damage and losses caused by these phenomena over the last 30 years in some vulnerable countries in Latin America and the Caribbean have been estimated by ECLAC at over 50 billion dollars.

In addition, the study estimated the economic effect of the earthquake on households, businesses in the area and on the main macroeconomic variables of the region.

## II. THE MAGNITUDE AND EFFECTS OF THE AUGUST 2007 EARTHQUAKE

On August 15, 2007, the country was hit by an earthquake measuring 7.9 on the Richter scale. This major earthquake, which impacted the Ica region and provinces south of Lima, disrupted the lives of roughly 431,000 persons, leaving more than 200,000 homeless and killing another 519. In addition, the water and sanitation systems collapsed -creating damages amounting to US\$ 27.62 million<sup>3</sup>-, 643 classrooms lay in ruins, 14 health facilities were destroyed, and two bridges collapsed. Consequently, a significant portion of the infrastructure critical for providing basic services to the population could not be used.

### The Economic Impact of the Earthquake on Water and Sanitation Systems

To what extent would earthquake-related damages and economic losses could have been reduced had disaster-prevention measures been adopted in the urban water and sanitation sectors of Cañete, Chincha, Pisco, and Ica?

In order to answer this question, an estimate of the economic impact from the August 15, 2007 earthquake on the following urban water and sanitation utilities operate: EMAPICA (Ica), EMAPISCO (Pisco), SEMAPACH (Chincha), and EMAPA Cañete (Cañete). This document presents some of the most important findings of this study.

## III. APPROACH TO ESTIMATE THE ECONOMIC IMPACT OF THE EARTHQUAKE ON THE WATER AND SANITATION SECTOR

A methodology developed by the Economic Commission for Latin America and the Caribbean (ECLAC)<sup>4</sup> was used to estimate the economic impact of the damages to water and sanitation services caused by the 2007 earthquake. It classifies the impact of a natural catastrophic event into *direct*, *indirect*, and *macroeconomic effects*.

3 Amounts in American dollars are based on the exchange rate US\$ 1.00 = S/. 2.80

4 ECLAC, "Guide for Social, Economic and Environment Impact Assessment in Disasters", Mexico, 2003.

**Direct effects** (damages) are those that impacted the water and sanitation sector infrastructure at the time of the natural event and right after it happened. Measuring the direct effects using the ECLAC methodology entails calculating the cost of restoring water and sewage systems to pre-earthquake conditions. In addition, an estimate was done of the cost of the damage under a scenario where the systems, in addition to being operational, were properly maintained when the natural event occurred. Lastly, the cost of the damage was also estimated under a scenario where the systems were built with earthquake-resistant materials and were properly maintained when the earthquake struck. The latter reflects a scenario where the water and sanitation utilities apply preventive risk management measures<sup>5</sup>.

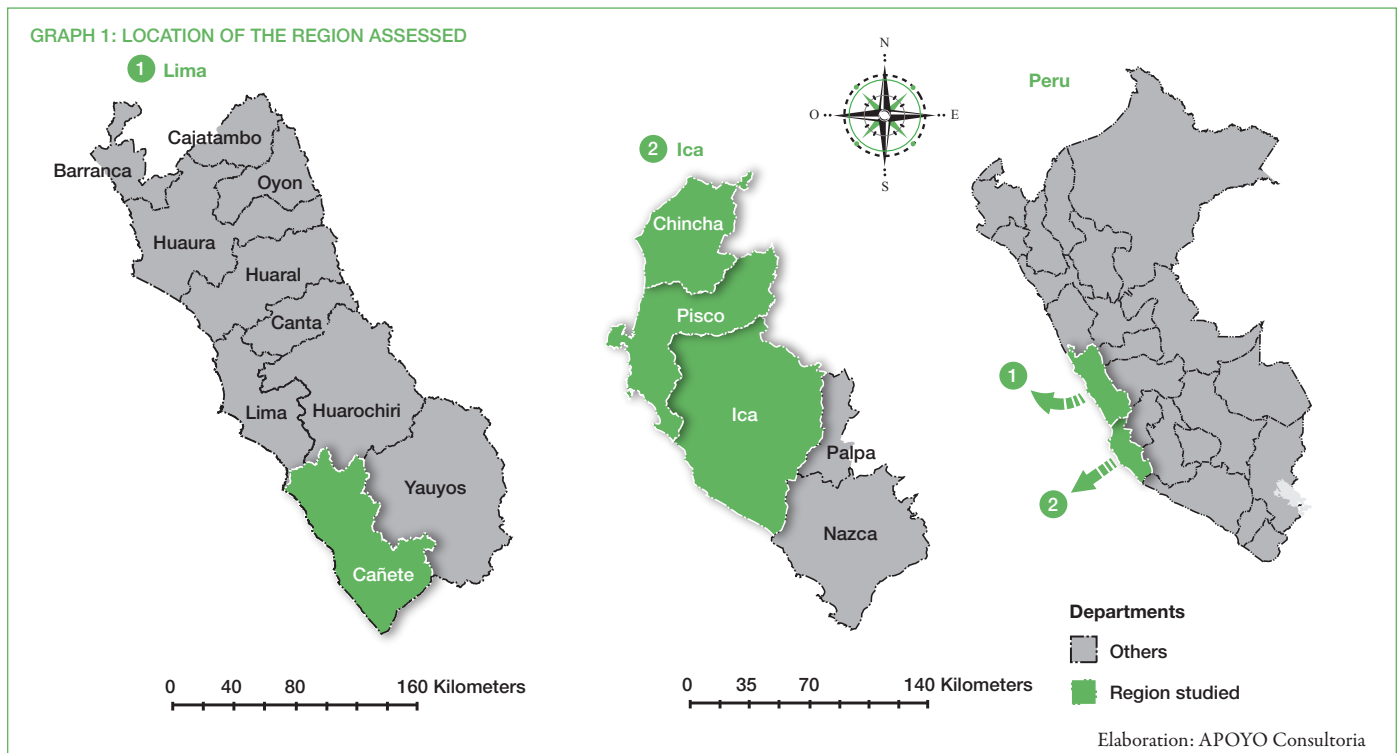
This approach facilitated the determination of the costs incurred by urban water and sanitation utilities in Peru owing to the absence of disaster risk management practices. In addition, an estimate was also done of the impact of the earthquake on households (household water and drainage service; health;

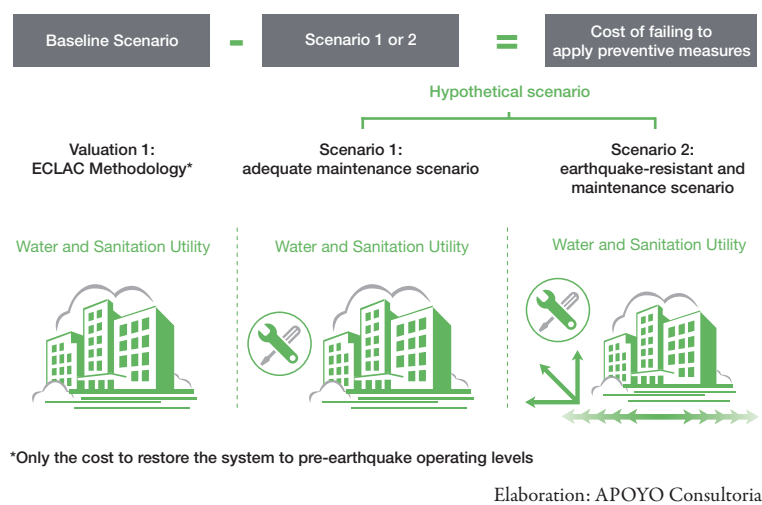
gender and the environment) and businesses that operate around the disaster area.

In order to calculate **the cost of not implementing risk management measures on the urban water and sewage systems prior to the earthquake in Ica, Pisco, Chincha and Cañete**, the estimates corresponding to the scenarios where the systems were maintained (scenario 1) and where systems were constructed with earthquake-resistant materials (scenario 2) were subtracted from the actual costs incurred to restore the systems to pre-earthquake operating levels (baseline scenario) (see Graph 2).

**Indirect effects** include (i) the loss of revenue by water and sanitation utilities from reduced billing as well as water losses resulting from the failure to repair direct damages sustained; and (ii) higher operating costs resulting from the temporary provision of the service during the reconstruction period. In order to estimate both, a calculation was made on the difference between revenue, water losses, and operating costs during the post-earthquake period and the figures that would have resulted, based on historical trends, had the earthquake not occurred.

<sup>5</sup> Risk management entails the adoption of measures to reduce existing vulnerability. In this instance, it refers to the reduction of the vulnerability of the component parts of the water and sanitation system through improvements in the quality and the maintenance of the system.



**GRAPH 2: HOW SHOULD THE COST OF THE FAILURE OF WATER AND SANITATION UTILITIES TO ADOPT RISK MANAGEMENT MEASURES BE ESTIMATED?**


Direct and indirect costs can be combined for purposes of estimating the overall scope of the economic impact caused by the earthquake.

Furthermore, the macroeconomic effects and the effects on households and businesses were considered as additional impacts on the region as a whole.

**Macroeconomic effects** include the extent to which the earthquake affected the main aggregate indicators of the region, namely:

- Gross domestic product (GDP): change in the aggregate value of water and sanitation utilities.
- Trade balance: registry of importations and exportations during a period of time.
- Public finances: change in government (central and local) revenues and expenditures.
- Prices and inflation: price changes fluctuations (water and construction materials).
- Employment: change in employment patterns and impact on revenue.

To quantify **the effects of the earthquake on households**, a quantitative survey was administered to the heads of households and homeowners in the region studied to obtain information on their activities, the impact on their incomes, the region's epidemiological patterns (inhabitants' vulnerability to diseases), and other possible changes linked to the earthquake.

Moreover, in order to estimate **the effects on businesses**, a qualitative methodology<sup>6</sup> was used to obtain data on the economic losses incurred by businesses during the post-earthquake period<sup>7</sup>; in particular, information was gathered on the damages to their water infrastructure and on sales and investment plans. An attempt was also made to ascertain the existence of a prevention culture in businesses.

Thus, the study estimated the economic impact of the earthquake (direct and indirect costs) on the urban water and sanitation sector in the four provinces studied. In addition, an assessment was made of the macroeconomic impact and earthquake's effects on the main victims in the region, namely households and businesses.

#### IV. PREVENTION PAYS OFF: 96% OF THE DIRECT COSTS COULD HAVE BEEN SAVED

The direct effects of the earthquake amounted to US\$ 27.62 million (see Table 1). This figure reflects the direct expenditures required in the aftermath of the earthquake to restore the water and sewage system to pre-earthquake operating levels. This figure is equivalent to 6.4 times the water and sanitation expenditures of the region's provincial municipalities<sup>8</sup> in 2007<sup>9</sup>.

**TABLE 1: WHAT WAS THE TOTAL AMOUNT OF THE DAMAGE TO THE WATER AND SEWAGE SYSTEMS? (MILLIONS OF US\$)**

	Chincha	Pisco	Ica	Cañete	Direct effects
Potable water systems	1.77	4.30	3.79	0.88	10.75
Sewage systems	4.55	8.72	2.76	0.84	16.87
<b>Total expenditure on emergency recovery projects</b>	<b>6.32</b>	<b>13.02</b>	<b>6.55</b>	<b>1.72</b>	<b>27.62</b>

Elaboration: APOYO Consultoria

It is important to note that 47 percent of total direct effects were concentrated in Pisco. While the higher intensity of the earthquake in Pisco would explain the fact that the damage

6 Semi-structured qualitative interview with business persons.

7 The values found in this section are not statistically representative.

8 The combination of activities to guarantee the supply of potable water, implement and maintain sanitary and sewage systems, and improve population sanitation conditions, and public cleanup activities. Included are activities related to planning, promotion, and development of sanitation service providers. (Source: the Ministry of Economy and Finance of Peru).

9 Total expenditures in 2007 by the Provincial Municipalities of Ica (US\$ 1.43 million), Chincha (US\$ 1.07 million), Pisco (US\$ 1.18 million), and Cañete (US\$ 0.68 million) amount to US\$ 4.35 million.

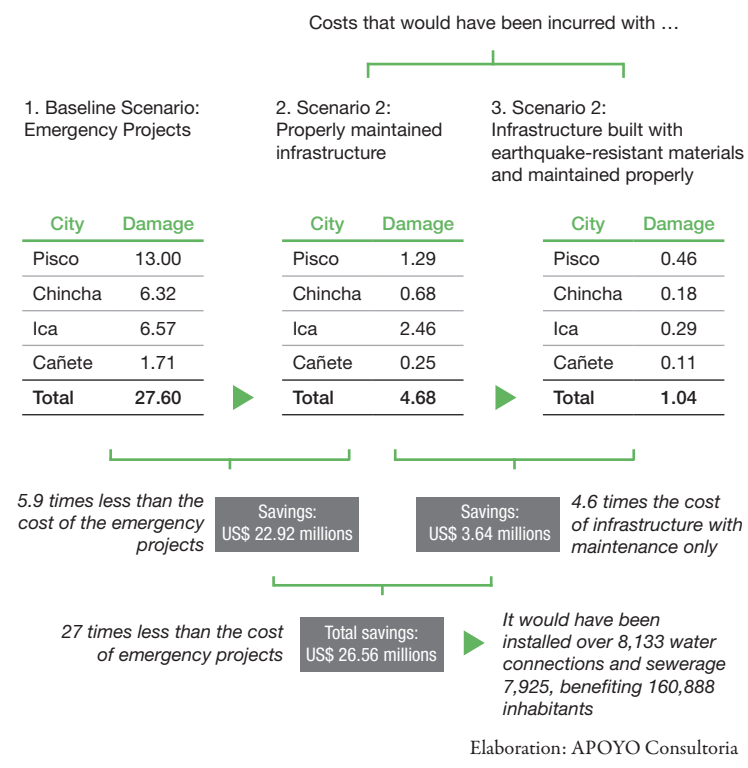


there was greater than it was in other cities<sup>10</sup>, its sewage system had been determined to be in critical condition prior to the earthquake. Consequently, its system was much more vulnerable than those of other affected cities.

Based on the results of the study, it is estimated that the extent of the damage to the systems would have been 5.9 times less had water and sanitation utilities conducted proper maintenance work on water and sewage systems. Consequently, a comparison of earthquake recovery costs with those that would have been incurred had the infrastructure system been adequately maintained points to a savings of US\$ 22.93 million. Furthermore, in addition to proper maintenance, if the infrastructure had been built using earthquake-resistant materials, recovery costs would have amounted to a mere US\$ 1.02 million in order to restore the infrastructure to pre-earthquake operational levels. In other words, up to 96 percent of the costs actually incurred could have been saved (see Table 2).

10 Maximum earthquake intensity in Pisco stood at VII-VIII on the modified Mercalli scale. In Chincha, Ica, and Cañete, maximum intensity was VII.

**TABLE 2: HOW MUCH COULD HAVE BEEN SAVED IF WATER AND SANITATION UTILITIES HAD IMPLEMENTED RISK MANAGEMENT MEASURES? (MILLIONS OF US\$)**



The figures obtained show that risk management should begin with ongoing maintenance of water and sewage systems. However, consideration should also be given to the use of better infrastructure materials, replacing pipes made of unsound materials (concrete) and vulnerable facilities (wells, irrigation tunnels, etc.) with facilities constructed with earthquake-resistant materials.

**V. OPERATING PROFIT OF SERVICE UTILITIES FELL BY US\$ 2.36 MILLION**

In the case of indirect effects, measured as the decline in the operating profits of water and sanitation utilities, the overall operating profit of the four utilities studied fell by US\$ 2.36 million or 29 percent of the total 2007 sales of these utilities.

It should be noted that the impact would have been much greater had these utilities not implemented effective commercial strategies to mitigate the impact of the earthquake on their earnings. For example, SEMAPACH conducted campaigns to identify illegal connections, register its users, collect revenue, and install meters. As a result, its sales increased fairly rapidly in the post-earthquake period.

**TABLE 3: COMPARISON OF RESULTS STATE TO OPERATING PROFIT IN WATER UTILITY EMAPISCO, YEARS 2007, 2008 AND 2009 (THOUSAND OF DOLLARS)**

Account	2007		2008		2009	
	Effective	Estimate	Effective	Estimate	Effective	Estimate
Sales	927	1,078	1,217	1,121	1,263	1,197
Sales' costs	1,303	1,355	1,279	1,397	1,346	1,573
Gross utility	-375	-278	-62	-276	-84	-375
Sales' expenses	177	201	355	176	346	186
Administrative expenses	479	390	638	305	631	328
<b>Operating profit</b>	<b>-1,032</b>	<b>-868</b>	<b>-1,055</b>	<b>-757</b>	<b>-1,060</b>	<b>-889</b>

Source: EEFF EMAPISCO  
Elaboration: APOYO Consultoria

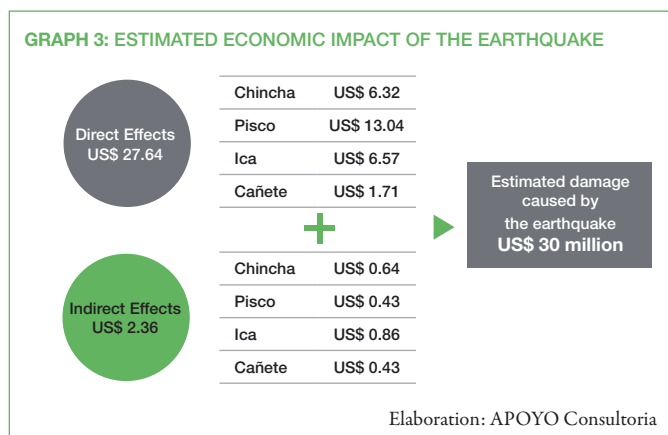
**TABLE 4: INDIRECT EFFECTS' ESTIMATION BY WATER UTILITY IN EACH PROVINCE (MILLION OF DOLLARS)**

Indirect effects	Chincha	Pisco	Ica	Cañete	Total effects
Operating profit decrease	-0.43	-0.68	-1.07	-0.57	-2.75
Operating profit increase	0.0	0.04	0.21	0.14	0.39
<b>Total by province</b>	<b>-0.43</b>	<b>-0.64</b>	<b>-0.86</b>	<b>-0.43</b>	<b>-2.36</b>

Elaboration: APOYO Consultoria

## VI. THE OPPORTUNITY COST TO THE URBAN WATER AND SANITATION SECTOR WAS HIGH (US\$ 30 MILLION)

Based on these calculations, the earthquake is estimated to have resulted in total losses to water and sanitation utilities of Ica, Pisco, Chíncha and Cañete amounting to US\$ 30 million (direct and indirect effects). This sum could have been used to provide services to 160,888 residents in the form of more than 8,183 potable water connections and 7,925 sewage connections, representing 7 percent and 9 percent of potable water and sewage connections, respectively, in the operating region of the water and sanitation utilities studied.



## VII. HOW WAS HOUSEHOLD WELLBEING AFFECTED?

More than half the households (66 percent) in the urban regions of Pisco, Chíncha, Ica, and Cañete were affected by the earthquake. The impact on households in such areas as household water and sewage service, health, gender, and the environment merits analysis.

### Drinking Water and Sewage Service

On average, 81 percent of households experienced interruptions or changes in water service over a 16-day period. Based on the results of the survey, water trucks were the main alternative source of water (69 percent)<sup>11</sup> during this period, which resulted in a weekly cost of approximately US\$ 5.36

11 Owing to the importance of water trucks as an alternative source of water during emergencies, comprehensive plans should be developed for ongoing distribution. To this end, water and sanitation providers should monitor the arrival frequency, schedules, regions, and registration by beneficiaries.

per household or the equivalent of 4 percent of the weekly income of an average household in the Ica department<sup>12</sup>.

Total additional expenditure by all households in the region studied, during the period taken to repair water and sanitation facilities (in the aftermath of the earthquake), is estimated at more than US\$ 470 thousand.

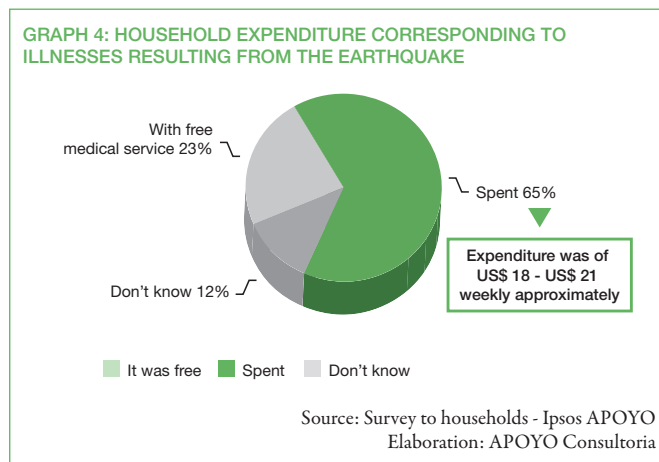
**TABLE 5: HOUSEHOLD ADDITIONAL EXPENDITURE DUE TO LACK OF DRINKING WATER**

Province	Average days without water	Additional payment (thousands of dollars)
Ica	12	141
Chíncha	21	143
Pisco	31	137
Cañete	7	49
<b>Total</b>		<b>470</b>

Elaboration: APOYO Consultoria

### Health Care

Although only 5 percent of the population became ill as a result of the earthquake, children were the most vulnerable (60 percent). There was no significant outbreak of gastrointestinal illnesses resulting from the water consumed, the lack of waste removal or the shortage of clean water for drinking and proper hygiene.



It is important to note that in the regions studied, measures were adopted to prevent the spread of diseases. For example, the number of hours that water was supplied was curtailed to avoid flooding from leaking pipes; typhoid fever, tetanus, Hepatitis A and B, and yellow fever

12 The monthly income of an average family in Ica Department was the equivalent of US\$ 580.71 in 2007.



vaccinations were administered; and water quality was continuously monitored.

Of the total number of households that had at least one member with an earthquake-related illness<sup>13</sup>, 65 percent spent between US\$ 18 and US\$ 21 per week. Only 23 percent received free medical care and medication.

Taking into account the estimated cost and the average time taken for individuals to recover, earthquake-related health care expenditure was between US\$ 6.1 million to US\$ 7.5 million, approximately. This number is comparable to the entire sum spent by the central government on health care in Ica during 2007.

### Gender

In the aftermath of a natural catastrophic event that heavily impacts a population, domestic chores<sup>14</sup> in most households were assumed largely by women (mothers – 70 percent, sisters – 2 percent, and other female members – 2 percent). In 15 percent of households, one member spent all of his or her time caring for the sick. Mothers were the main caregivers. 63 percent of households reported that at least one person was assigned the task of collecting water, with women also bearing primary responsibility for this task (36 percent).

13 Includes respiratory, diarrheal, and skin disorders as well as contusions.

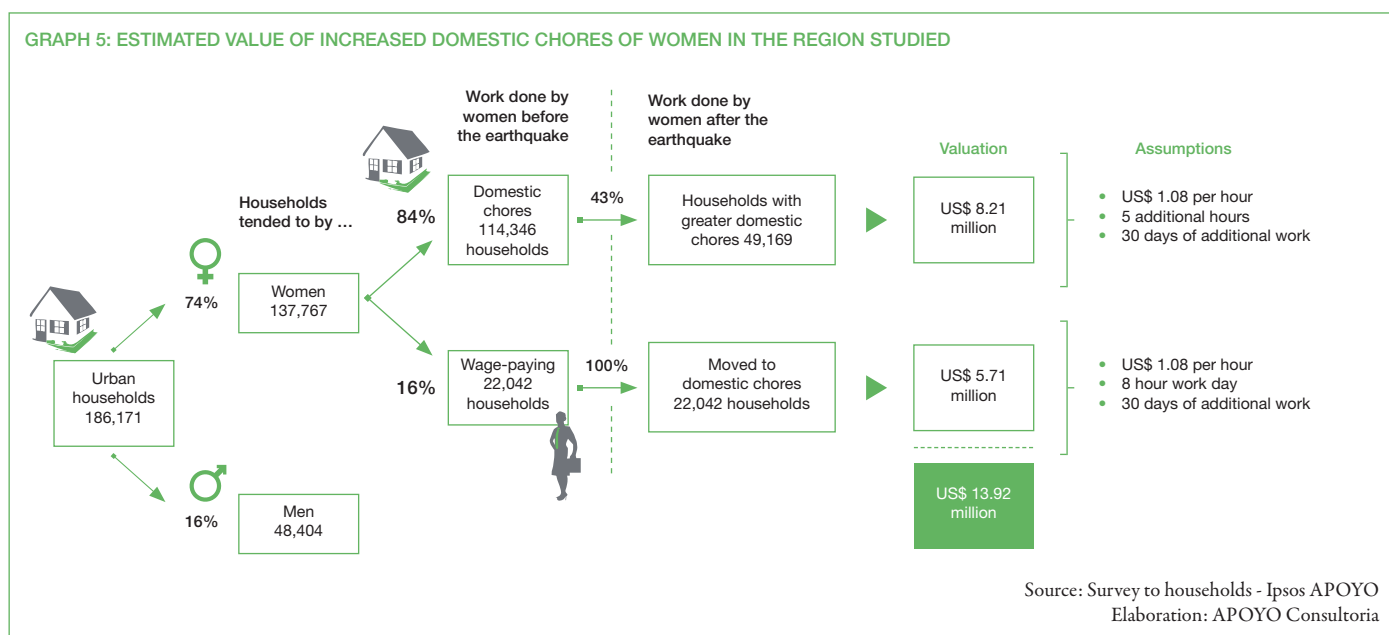
14 Domestic chores include caring for children and sick or injured family members, obtaining food rations or donations, and carrying water.

The Graph 5 shows the impact of the earthquake on domestic chores. Consideration was given to homes where women increased their domestic chores (84 percent) and those where women had to give up wage-paying work to perform domestic chores (16 percent). The total monetary value of the domestic work performed by women as a result of the earthquake stands at US\$ 13.93 million for the entire region studied (equivalent to 0.3 percent Ica's GDP in 2007). This number corresponds to US\$ 193.6 per household in cases where the earthquake increased domestic chores. However, instead of being viewed as household income, this sum should be considered an expenditure equivalent to 3 percent of the average annual family income in the Ica region.

### Environment

The impact of a natural catastrophic event such as the 2007 earthquake on water and sanitation systems can lead to environmental changes that adversely affect a population's health and wellbeing.

The earthquake disrupted the functioning of the sewage system of 14 percent of households. As a result, a portion of the population used outhouses or latrines, portable bathrooms, or the home of another family member. To a lesser extent, people used open land for defecation.

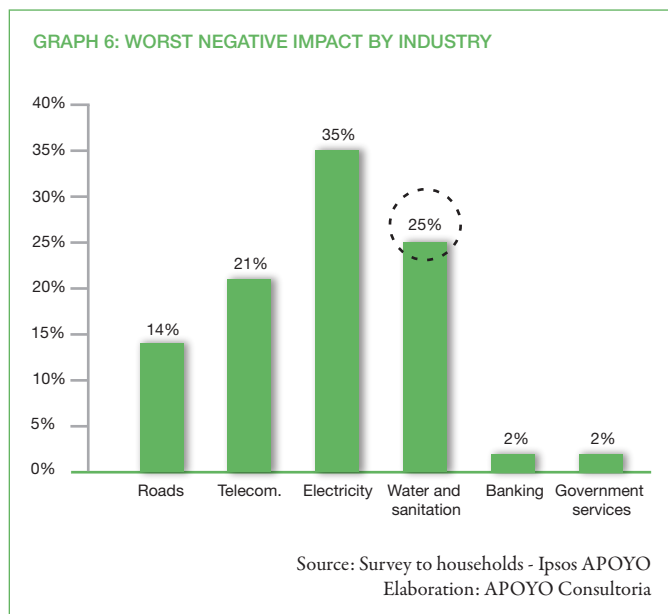


However, a comparison of the pre- and post-earthquake situations shows a 4 percent increase in homes that used proper solid waste disposal methods such as trash collection by garbage trucks or payment to a third party to collect household waste. This increase resulted from the rebuilding effort and the technical assistance provided in the aftermath of the earthquake.

### VIII. WHAT WAS THE IMPACT ON BUSINESSES?

The earthquake had a significant impact on business activities given that various services that support them were affected. According to businessmen surveyed in the affected region, business activities were most heavily impacted by power outages (35 percent) and damage to and problems with water and sanitation services (25 percent)<sup>15</sup>. (See Graph 6)

Although the impact of the earthquake was small for 80 percent of businesses, it was prolonged (in the case of 52 percent of businesses, sales were affected for over two months). In addition, it was noted that at least 60 percent of businesses in the sample with investment plans prior to the earthquake had to halt or postpone these plans, a situation that continue for some time<sup>16</sup>, as a result of earthquake damage.



15 Businesses were estimated to be without these services for up to 15 days.

16 Some of the survey respondents reported that they had in fact postponed their investment plans owing to the earthquake and that up to the time of the survey, they still had not moved forward with these investments. The surveys were conducted in May 2010.

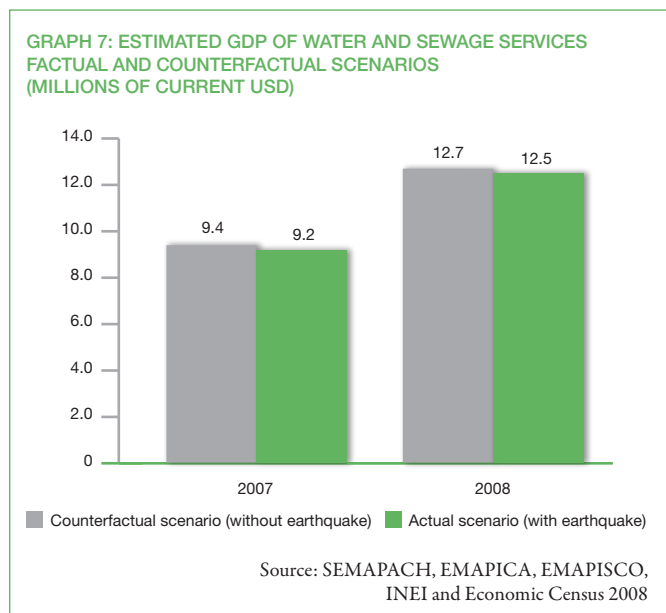
Lastly, it was revealed that 70 percent of businesses did not have insurance to transfer risks from earthquakes, nor did they have insurance to cover accidents or other business-related.

### IX. WHAT WERE THE MAIN MACROECONOMIC EFFECTS?

The macroeconomic effects were calculated by taking into account the change in the main aggregate accounts of the affected region: GDP, trade balance, public revenues, prices and inflation, and employment.

#### GDP of Water and Sewage Services

The 2007 and 2008 decline in aggregate income for the water and sanitation sector in Ica as a result of the earthquake stood at roughly US\$ 180,000 per year or the equivalent of 1.8 percent of the total estimated for the sector in 2007 and 1.3 percent in 2008<sup>17</sup>.



#### Trade balance

Regarding the impact on the water and sanitation utilities's exports ratio, the results are not relevant. This companies do not export. For this reason, this variable did not affect the trade balance. On the other hand, regarding the imports

17 Using the ECLAC methodology (2003), only the effect of revenue losses by water and sanitation providers was considered as the impact on GDP. Impact on stock (infrastructure) losses are excluded. While the loss of stock leads to reduced production capacity of water and sanitation providers, this is reflected in the decline in future rather than current flows (2007).

ratio, and according to interviews with operating managers of each water utility, usually, urban utilities buy building materials, especially pipes which represent 93% of their total expenses in materials from the national industry.

### Public Finances

The impact on public finances (i.e. the impact on the revenue of the national and sub-national governments) is due to three factors: (i) lower taxes collected by the government owing to the decline in production among water and sanitation utilities; (ii) lower revenues of public enterprises; and (iii) higher public expenditures owing to the investment in reconstruction and damage repair work. (See Table 6)

TABLE 6: EFFECT ON PUBLIC FINANCES, 2007-2009 (Thousands of US\$)

Public Revenue/Expenditure	Thousands
a. Tax collection associated with the change in the production of goods and services	2,5
b. Change in the revenue of public enterprises	0,1
c. Investment expenditure on reconstruction works and damage repair	21,8
<b>Net Effect (a + b - c)</b>	<b>-19,2</b>

Source: FORSUR and SUNASS  
Elaboration: APOYO Consultoria

Although tax collection associated with changes in the production of goods and the revenue of public enterprises<sup>18</sup> was positive, this was offset by the major investments required to rehabilitate water and sanitation services. Consequently, the overall net effect was negative (roughly US\$ 19.3 million). This figure is equivalent to 26 percent of the 2007 revenue collected in the form of sales taxes (*impuesto selectivo al consumidor ISC*), income taxes (*impuesto a la renta IR*), and the selective consumption tax.

Total government sales taxes (net effect) on investments by FORSUR (the entity in charge of reconstruction) and other entities in sanitation infrastructure reconstruction stood at approximately US\$ 2.5 million.

18 In 2007, the revenue of water and sanitation providers fell sharply (US\$ 375 thousands). Though smaller, these losses continued in 2008 (US\$ 150,000), with the trend being reversed in 2009 as a result of improved management and investments, with the earthquake scenario generating more revenue than the non-earthquake scenario (US\$ 631.8).

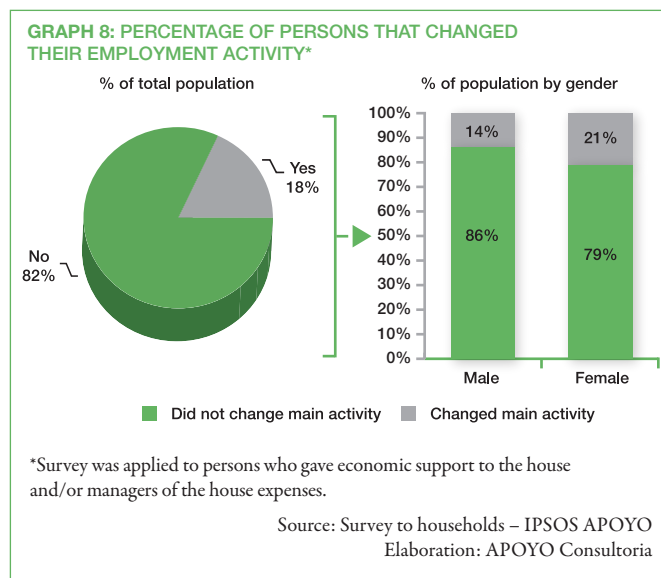
### Prices and Inflation

Water price increases were linked to changes in the wholesale price index (WPI) rather than to the effects of the earthquake. These adjustments affected 30 water and sanitation utilities in 2007 and 2008. However, owing to the damage in infrastructure caused by the earthquake, demand for water and sanitation construction materials rose. This surge in demand may have driven up the prices of such construction materials such as PVC pipes, which rose by 16 percent between August and October 2008.

### Employment

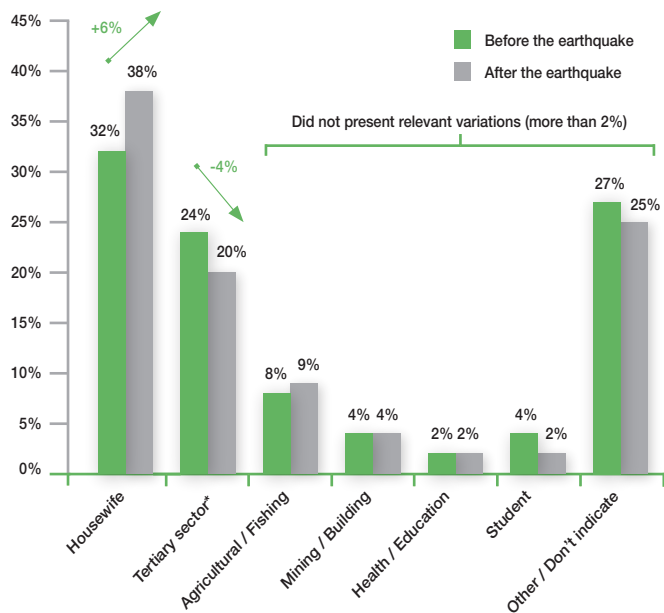
The impact of the earthquake is measured both in terms of the direct loss of employment and the decline in incomes owing to fewer hours worked and lower pay.

Specifically, 18 percent of heads of household switched jobs as a result of the earthquake, given that more time was needed to attend to family needs. Nevertheless, as observed in Graph 8, this impact had more implications on women, as 21% of them had to change their main activity; in the case of men this percentage represents 14%.



As part of the earthquake’s effects, it’s observed a change in the type of activities performed by the local population. After the event, there is an increase of 6% of persons who dedicate to domestic activities. In contrast, there is a decrease of 4% in the population dedicated to tertiary sector. In the other sectors there is no relevant variation (see Graph 9).

GRAPH 9: ACTIVITY BEFORE AND AFTER THE EARTHQUAKE



\*Includes the following service activities: tourism, industry and transport.

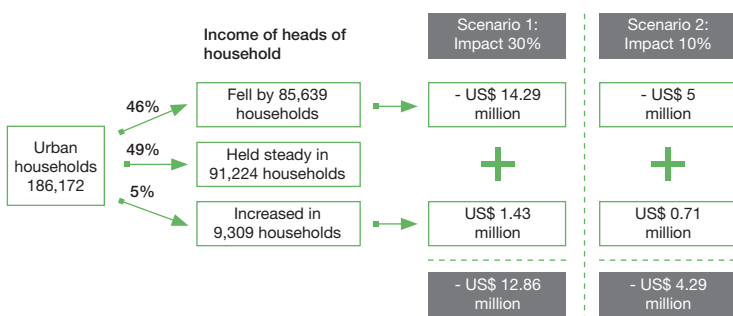
Source: Survey to households – IPSOS APOYO  
Elaboration: APOYO Consultoria

**Income impact**

Besides producing an impact in the type of activities performed in the region, the earthquake had a very important impact in the income of the population: 46%<sup>19</sup> of those surveyed said that their incomes decreased; 49% said that theirs did not vary; and only 5% said their incomes increased. In average, their incomes were impacted by a period of two months.

19 This estimation includes those persons who changed activities and those who continue performing the same activity after the earthquake. Students and housewives (37% of the persons surveyed) were excluded for this estimation.

GRAPH 10: ESTIMATED IMPACT OF THE EARTHQUAKE ON THE INCOME OF HOUSEHOLD HEADS IN THE REGION STUDIED



Source: Survey to households - Ipsos APOYO  
Elaboration: APOYO Consultoria

In order to estimate the negative impact of households, two scenarios were considered: (i) a 30 percent impact on monthly income (scenario 1); and (ii) a 10 percent impact on monthly income (scenario 2)<sup>20</sup>, for both the group whose income fell (46 percent) and the group whose income rose (5 percent). In both cases, a two-month period and monthly income of US\$ 281.43<sup>21</sup> were used. As a result, under scenario 1, it was estimated that, overall, household heads in the studied region lost US\$ 12.86 million (0.3 percent of Ica’s GDP), while under scenario 2, income was projected to have fallen by US\$ 4.29 million. These figures represent 0.5 percent and 1.5 percent of the total annual income of urban families in the Department of Ica, respectively.

**X. MAIN CONCLUSIONS**

- Overall, the earthquake caused damages to the water and sanitation systems of the towns of Cañete, Chincha, Pisco and Ica with a total amount of US\$ 30 million<sup>22</sup>. This money could have been used to install over 8,183 water connections and 7,925 drainage systems to benefit 160,888 inhabitants.
- Of this total, the damages or direct effects (those related to work for the recovery and return of water and sanitation systems to pre-disaster status) cost US\$ 27.6 million. This is 6.5 times the 2007 budget of the provincial municipalities in the water and sanitation sector of the studied area.
- The results show that, if the urban utilities studied had performed ongoing maintenance of the water and sanitation systems, the estimated value of the damage would have been 5.9 times less; in other words, approximately US\$ 22.9 million would have been saved. Moreover, if the infrastructure for these services had been constructed of ductile material, if the quality of the soil in which the systems were installed had been evaluated and if ongoing maintenance had been performed on wells and tunnels, etc., a total of US\$ 26.6 million would have been saved on repairing the water and sanitation systems of service providers in the Sur Chico.

20 Two scenarios were considered owing to a wide range of answers present in the data. The percentages used reflect the smallest (10 percent) and biggest (30 percent) decline reported by survey participants.

21 Source: National Household Survey, 2007.

22 Figure obtained by adding direct and indirect effects.

4. In addition, indirect effects cost US\$ 2.3 million. This amount is equal to 29 percent of the service providers' total sales in 2007. However, the result may have been under-estimated because of policy changes introduced by EMAPISCO and SEMAPACH<sup>23</sup> to increase operating revenue following the earthquake.
5. As regards macroeconomic effects, the impact of the earthquake was calculated in relation to the following variables: (i) GDP for drinking water and sanitation in Ica; (ii) government finance; (iii) water rates and inflation; and (iv) possible effects on employment.
  - The decrease in GDP for drinking water and sanitation services in Ica attributable to the earthquake for 2007 and 2008 was approximately US\$ 180.714 for each year. This represents an estimated 1.8 percent and 1.3 percent of GDP in Ica for 2007 and 2008 respectively.
  - The impact on government finances was negative and was calculated in relation to three indicators: (i) variation in taxes collected by Central Government due to variation in production of goods and services; (ii) variation in the income of public enterprises; and (iii) higher costs of investment to reconstruct works and repair damage. The first two indicators are positive. However, they are offset by the amount invested to rehabilitate the water and sanitation service. Thus, there was a net negative effect of approximately US\$ 19.3 million. This is equivalent to 26 percent of the amount collected by the *Superintendencia Nacional de Administración Tributaria* (Peruvian Tax Administration Office – SUNAT) in Ica in 2007 in the form of general sales tax, income tax and selective excise tax.
  - Water rates have increased but this was due to adjustments in the wholesale price index and not to the effects of the earthquake.
  - As far as employment is concerned, 18 percent of heads of household changed their principal activity: the shift was mainly towards homemaking activities. In addition, it is estimated that heads of household in the region studied lost a total of between US\$ 4 and US\$ 13 million (0.2 percent of the GDP of Ica in 2007).
6. An analysis was made of the effect of the earthquake on the well-being of households from the period immediately after the earthquake until the beginning of the study. On the basis of a survey which collected quantitative data from a sample representative of the influence area, the following thematic modules for households were evaluated: 1) water and sanitation service at home; 2) health; 3) gender; and 4) environment.
7. In 81 percent of households, water service was interrupted or affected for an average of 16 days. As a result, water trucks were the principal alternative source of water (69 percent). This represented a weekly cost of US\$ 5 for each household which had to use this alternative source. And that amount represents 4 percent of the weekly earnings of an average household in the department of Ica.
8. Because of the earthquake, 14.3 percent of household members fell sick for reasons attributable to the disaster, mainly the lack of waste disposal (28 percent). Children and mothers were the most vulnerable. Spending on health in these households averaged between US\$ 18 and US\$ 21 a week. Depending on the duration of the prevalence of diseases, the spend amount of the studied area varied between US\$ 6.1 million and US\$ 7.3 million.
9. The earthquake had a different effect on men and women, affecting the latter more. This was because of the amount of time that women had to devote to domestic chores<sup>24</sup> and also because they had to give up paid work in order to perform those chores. The main earthquake-related domestic functions were looking after sick relatives and fetching water. For example, in 36 percent of households, mothers were responsible for collecting water; and at least half of them devoted between one and three hours a day to this activity. In general, the increase in domestic work was approximately five hours a day for 30 days. This type of work was valued at US\$ 8 million for the area studied. In addition, in 16 percent of households, women had to quit their regular jobs to perform this type of work; the total losses were US\$ 5.7 million.
10. Regarding, the effect on the environment, 10 percent of the population had to relieve themselves outside, instead of in the appropriate place (hygienic amenities).

23 In this case, the results appeared to be so skewed that it was decided not to consider any figure subsequent to November 2008. This means that more than one year was omitted from the calculation of indirect effects, in comparison with the other service providers.

24 According to the study, this term refers to unpaid work related to domestic activities.



Regarding, solid waste, it was found that 40 percent of households changed their garbage disposal arrangements. However, use of appropriate methods<sup>25</sup> of garbage disposal increased by 4 percent because of post-earthquake reconstruction work and technical assistance.

11. The commercial strategies used by the service providers to offset the impact of the earthquake on their revenue were effective. In some cases, sales volume actually increased. This was due to the firm's efforts to generate income not previously earned, using the following mechanisms: detection of clandestine connections; recounting of users; upgrading of damaged infrastructure; aggressive policy to recover inactive clients; collection and installation of micro-meters. In several instances, revenue was recovered quite rapidly and reached pre-disaster levels.

12. With regard to sanitation infrastructure and operating indicators from the service providers themselves, the systematization of information for better disaster risk management still seems rudimentary and disorganized. This made the analysis more complicated. For example, much of the service providers' data are not in digital format and are kept in places where they may be damaged or lost. This was the case for EMAPISCO: because of the earthquake and the collapse of its offices, data prior to 2001 were lost.

13. The study shows that disaster risk management is not commonly practiced by service providers in the sector. In other words, before the earthquake, information on former natural catastrophic events, soil quality or exposure of systems, have not been used in order to have accurate measures that could have been use to reduce the vulnerability of the components of the water and sanitation system. The service providers do not know their risk and therefore to not undertake or plan the necessary projects to reduce or mitigate it. They do not have or do not use emergency plans and were not responsive at the time of the earthquake.

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25 As indicated, suitable methods are leaving garbage to be collected by the garbage truck or paying for it to be collected.





