A Note on Transparency and Loss of Life Arising from Earthquakes

N. Ambraseys

Professor, Department of Civil Engineering, Imperial College, London SW5 2BU, UK,
email: n.ambraseys@imperial.ac.uk

ABSTRACT

This note was prompted by the earthquake of 12 January 2010 in Haiti, which is not the only earthquake in recent years in which hundreds of thousands of people have been killed, in contrast to the near-zero death toll caused by earthquakes of the same magnitude elsewhere (viz.New Zealand 03.09.10). The Haiti earthquake raises several points that must be addressed in any realistic attempt to mitigate the loss of life arising from earthquakes, in particular the question of whether this enormous difference in human losses is almost entirely due to houses having been poorly constructed due to corrupt practices that allowed poorly sited and constructed houses to be built in seismic regions.

Keywords:
Loss of Life;
Transparency; Haiti;
CPI; GNI; Corruption

1. Introduction

Corruption or lack of transparency may be defined as the abuse of entrusted power for private gain, in the present case in the siting, designing, building and maintaining of engineered structures in seismic regions, such as Haiti and New Zealand.

What follows is an inquiry into the effect of corruption on loss of life in earthquakes globally, which has been carried out for two reasons. The first is to see to what extent wealth affects the degree of corruption in a country. The second is to assess the effect corruption has on the vulnerability of houses to earthquake damage, which ultimately is responsible for the loss of life. These questions are rarely aired or discussed in technical papers, despite the fact that corruption today weakens insidiously all the efforts that are made to improve the siting, design, construction and maintenance of structures to resist earthquakes and mitigate loss of life.

2. The Earthquake Problem

Earthquakes are among the most destructive natural hazards to the works of man, most certainly concerning loss of human life, and, although they cannot be prevented, their disastrous effects can be minimised. The sudden loss of lives and crippling of the economy, particularly of a poor country, may bring about unexpected and long-lasting social and even political upheavals, examples of which we have seen in the past.

Earthquakes are destructive because man has made them so by investing his wealth with a disregard for the hazards that Nature may have in store for him. This stems from a variety of causes, chiefly lack of education and apathy, which is due to ignorance, and also from a simple lack of awareness of, or interest in, the need to apply existing technical knowledge to alleviate such hazards.

Differences in attitude to earthquake hazards in various countries cannot be explained in terms of the magnitude or the frequency of such disasters alone. It is not only lack of education, scientific knowledge or technological capability that is at fault, but rather the consequences of its corrupt use once it leaves the realm of technology and enters the realm of human affairs.

Seismic codes and regulations are designed to guarantee the earthquake safety of houses and other engineering structures in seismic regions. Yet, despite the advances which have been made in earthquake-resistant design, the loss of life continues to increase, with the Haiti earthquake killing 250,000 people. Furthermore, this is not the only earthquake in recent years to have caused comparable losses; the earthquake of 2005 in Kashmir killed 79,000 people, and in the Sichuan earthquake of 2008 in China 51,000 people perished.

A comparison of earthquake fatalities with losses of life from other preventable causes shows that during the period 1980-2009 the average number of people killed annually by earthquakes worldwide has been about 20,000, a number that could have been greatly reduced by appropriate siting and building of structures.

These losses are comparable to the number of people killed annually by motor cars (35,000) or drugs (32,000) in the *USA* alone [1-2], while preventable diseases kill more people. Yet, although an earthquake may be no more horrifying than road accidents, the impact of its destructiveness is more traumatic because it involves wholesale rather than piecemeal catastrophe, just as a massacre appears more horrifying than a series of murders. Indeed, the fact that road accidents and losses from earthquakes can be reduced makes the number of their victims infuriating, rather than terrible.

Of course, one may say that this increase in human losses is partly due to the growth of population, urbanisation and industrial development. But it can be shown that this increase is also due to the fact that technical knowledge arising from scientific progress has not been reflected in practice and that its application is hindered in the sense that in some countries earthquake regulations and building control are seen as instructions that must be followed, while in other countries they are considered to be only suggestions, and in many countries they are merely empty words. One must ask why this is so. The answer is simply that misapplication of the technological knowledge that exists occurs because of an inability to manage a corrupt social system, and sometimes because of an inability to apply such knowledge.

It is not uncommon after an earthquake, particularly during a reconstruction boom, that the enforcement of building controls is not sufficiently strict and codes of practice are violated, becoming the victim of what might be called a lack of transparency. Obviously one may ask why, despite the scientific and technological achievements in recent years, the loss of life keeps on increasing steadily with time. Certainly, apart from the scientific and technical reasons which may be responsible, there must be also other, non-technical causes, which are not so apparent, that could explain these enormous losses of life. One of these causes is the way in which engineered structures are sited, designed, built and maintained. Quite simply, it is not realised that earthquakes do not kill people; it is the houses we build that do, and that "acts of God" of today are often tomorrow's acts of criminal negligence

The influence of corruption, not least corruption among politicians, is a subject regarding which there is increasing concern among economists and engineers. The experience, common sense and intuition of the practicing engineer do point to corruption as one of the most important causes responsible for the exorbitant material and life losses in earthquakes.

Corruption or lack of transparency may be defined as the abuse of entrusted power for private gain; in our case, in the siting, designing, building and maintaining of engineered structures in seismic regions. The degree to which corruption is perceived to exist among the people, public officials and politicians in different countries is ranked annually by the Corruption Perceptions Index (*CPI*) [3]. This index is in fact a "poll of polls" representing the average scores which individual countries have been given by international business and financial experts when polled in a variety of contexts. It assesses the level at which corruption is perceived by businessmen as impacting on commercial life and as such the *CPI* is less reliable for countries concerning which there are fewer sources of information.

The experts who began to survey the *CPI* sources starting in 1995 were business people from industrialised or less developed countries and emerging market economies. A *CPI* score relates the perception of the degree of corruption as seen by business analysts and scores countries on a scale from 0 for highly corrupt or zero transparency to 10 for highly clean or transparent.

Since the *CPI* is based on data from the past two to three years, it is by nature only an index and its values for different years are not necessarily comparable. This means that a change in perception of corruption for a particular country would emerge in the index only over longer periods of time (see Transparency International 2010) [3].

Year-to-year changes in a country's score result not only from a changing perception of a country's performance but also from a changing sample and methodology. Each year, some sources are not updated and must be dropped from the *CPI*, while new, reliable sources are added. With different respondents and somewhat differing methodologies, a change in a country's score may also relate to the fact that different viewpoints have been collected and different questions asked, so it is often difficult to improve a *CPI* score over a short period, such as one or two years.

One of the difficulties here is that what is legally defined or perceived to be corruption differs between countries: a political donation that is legal in one jurisdiction may be illegal in another; a matter viewed as acceptable tipping or "pourboire" in one country may be viewed as bribery in another. The causes and consequences of corruption and their solutions tend to be intertwined, but each case is a special case for which the lack of long-term observational data prevents the derivation of general rules.

Figure (1) shows the distribution of the standard deviations of the average *CPI* estimates for 153 countries over the period 1995-2009, which is less than 10% and is not statistically significant.

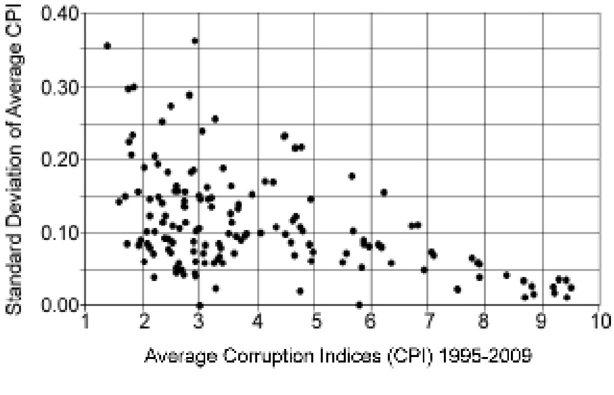

Figure 1. Standard deviations of the average Corruption Perceptions Indices (CPI) for 153 countries.

CPI estimates are available for more than 150 countries, but only for the period 1995-2009. The variation of *CPI* with time for a number of countries is shown in Figure (2).

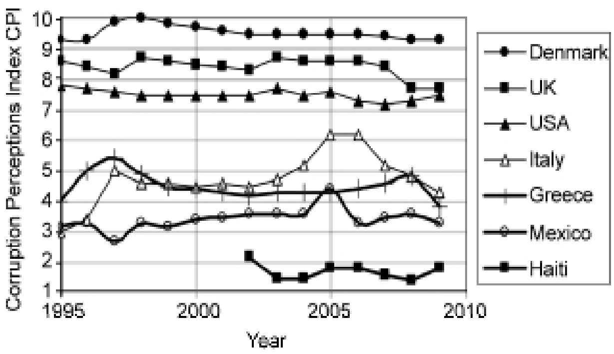

Figure 2. Variation of the annual Corruption Perceptions Index (CPI) for seven countries for the period 1995-2009.

The next question: "which is the most important quantifiable parameter that affects the value of the *CPI*?". If not the most important, the most obvious is certainly the relative wealth of a country which has produced a stable constitution guaranteeing the rule of law.

A standard measure that allows comparison of wealth between countries or across economies is the Gross National Income per capita (*GNI*) [4]. It provides a country's final gross national income in dollar value divided by its population and reflects the gross average income of a country's citizen.

The World Bank uses two methods to estimate *GNI*, the Purchasing Power Parities (*PPP*) method and the Atlas (*A*) method. In the *PPP* method conversion factors take into account differences in the relative prices of goods and services, thereby providing a better overall measure of the real value of output produced by an economy compared with other economies. *GNI* (*PPP*) is measured in current international dollars, which, in principle, have the same purchasing power as a dollar spent on *GNI* in the *US* economy. Because *GNI* (*PPP*) provides a better measure of the standard of living of residents of an economy, it is the basis for the World Bank's calculations of poverty rates at $1 and $2 a day.

In the Atlas method the official estimate of the size of economies used by the World Bank is the *GNI* converted to current *US* dollars using the Atlas method. *GNI* (*A*) takes into account all production in the domestic economy (i.e., *GDP*) and smoothes exchange-rate fluctuations by using a three-year moving-average, price-adjusted conversion factor.

The two methods, Atlas and *PPP*, therefore give GNI estimates that are numerically different, with the latter method giving larger values than the former in most cases. Figure (3) shows this for 147 countries, with *GNI* (*PPP*) estimates being larger for developing countries.

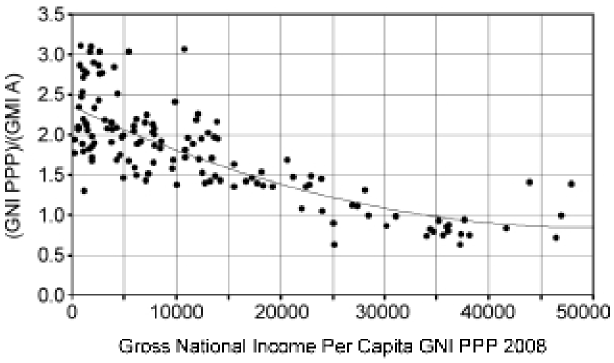

Figure 3. Comparison of the 2008 GNI Atlas ($) with the GNI (PPP) estimates for 147 countries.

For the comparison of wealth between countries using average *GNI* estimates we chose the Atlas method with data averaged over the period 1960-2009, which is the longest period for which reliable information about the loss of life due to earthquakes is available.

3. Effect of Gross National Income Per Capita (GNI) on Corruption

The effect of the average *GNI* on the *CPI* was investigated using the minimum, maximum and average values of *GNI* for each country, adopting finally average estimates.

I tested first the data for the European Union, that is for 27 countries for the period 1995-2009. As can be seen from Figure (4), the data confirm beyond doubt that the wealth of a country does affect the degree of corruption.

Equally satisfactory results were obtained from the correlation of the average Gross National Income per capita (*GNI* Atlas) with the mean *CPI*. Figure (5), which shows a plot of the data from 148 countries for the period 1960-2009, leaves little doubt that there clearly is a strong dependence of *GNI* on the *CPI*.

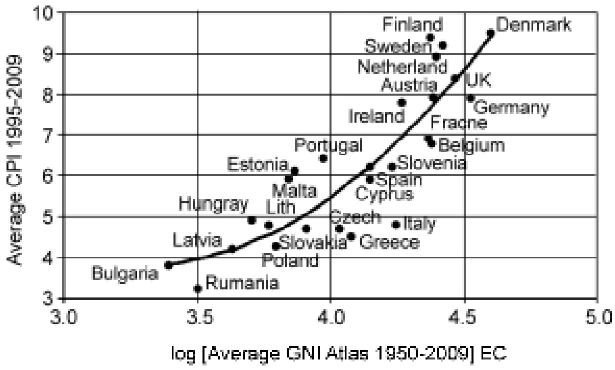

Figure 4. Effect of average Gross National Income per capita (GNI Atlas) on the average Corruption Perceptions Index (CPI) for the period 1995-2009 for countries of the European Union.

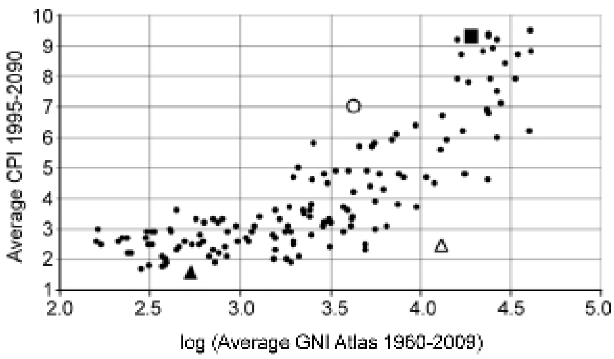

Figure 5. Effect of average Gross National Income per capita (GNI Atlas) on the Corruption Perceptions Index (CPI) for the period 1960-2009, for 148 countries worldwide. The solid square and triangle correspond to New Zealand and Haiti, respectively; the open circle and triangle are for Chile and Libya, respectively.

Lack of information and the uncertainties involved in the assessment of the available *CPI* values, particularly concerning the actual regional distribution of the *CPI* within a large country, do not allow refinement of the results by taking into consideration other variables.

The loss of life in a single earthquake depends on the population density of the region, and this must be taken into consideration when casualty numbers are calculated, compared with those from other earthquakes or used in the analysis. Even earthquakes of relatively small magnitude can exact a terrible toll when they happen to occur near, or in, a populous urban centre located in an area with an otherwise low population density, whereas they may pass almost unnoticed in a very sparsely populated region.

Here, the main interest is in the effect of corruption on the number of deaths resulting from a single earthquake (*DRE*) [5], which is defined as the number of people killed by the collapse of houses due to ground shaking, excluding losses of life arising from aftershocks and from zero-magnitude effects such as landslides, fire and tsunami, and missing people. It differs from *DRE*, which is the commonly used designation for the number of fatalities caused not only by ground shaking but also by secondary earthquake effects such as landslides, fire and tsunami, and including missing people.

In the original sources and the local press one can find examples in which the number of fatalities has been exaggerated, presumably with the purpose of attracting attention in the hope of receiving more generous assistance, or has been inaccurately reported for various other reasons, including political biases leading to the downplaying or exaggeration of the number of lives lost. Also there have been instances in which the intensity of the earthquake has been reported as having been larger than it really was, in an attempt to explain away the collapse of an otherwise unjustifiably large number of substandard, vulnerable houses with great loss of life. There are also cases in which casualty figures did not exist at all because of official restrictions on divulging or publishing data about losses of life related to earthquakes, particularly in the *USSR*, in China, and to a lesser extent elsewhere, a restriction that lasted for a long time.

Some of the factors which affect the values of *DRE* are difficult to evaluate. The population density and the vulnerability of the building stock in the epicentral region of an earthquake are two of them. Even within the short period of the last 30 years, there has been a rapid decrease in rural population and an increase in urban population, particularly in developing countries. This implies a time dependence both of the population density and of the vulnerability of the built environment, which is difficult to account for in the assessment of *DRE*.

Another difficulty is that *DRE* depends on the value of the *CPI* not of the year in which an earthquake causes the collapse of houses but of the year they were built, perhaps decades earlier. *DRE* values depend even on whether an earthquake happens at night or during daytime, in the winter or in the summer, in a mountainous region or in a valley, and on whether it occurs after strong and protracted foreshocks with or without warning. An earthquake occurring on a winter night is likely to kill two to five times more people than if it happened during a summer morning, particularly in a rural region. There are other common factors between *DRE* and the *CPI* that are not easy to identify. The *CPI-DRE* relationship is unlikely to be a direct one, since other variables, such as time effects, intervene and involve considerable uncertainties, which there is no foreseeable way of estimating.

For the period 1980-2009 there were 132 earthquakes in 37 countries, which, in this 30-year period, have caused a total loss of 590,564 lives, or on average 19,685 deaths per annum.

The location, depth, magnitude and aftershocks were reassessed, and the vulnerability of the predominant type of affected building stock was recorded. An approximate classification of the perceived vulnerability of houses was derived from reports, recent site visits and opinions of colleagues familiar with the affected region. Population density at the time of the earthquake was estimated on a comparative basis and divided into four categories.

The period 1995-2009 is the only time period for which *CPI* values are available and for which the effect of the *CPI* on *DRE* can be assessed, which is a very short period of observations. However, since corruption does not seem to change very rapidly with time, it may be safe to assume that on average *CPI* values from 1980 to 1994 did not differ significantly from those for 1995 and that the observations may be extended backwards by 15 years. For the period 1980-2009 the influence of the *CPI* on the death toll *DRE* was examined for earthquakes of $6.8 \leq M \leq 7.9$, a range of magnitudes for which information is more complete.

In order to ensure that damage information was representative of an epicentral area on land, earthquakes located more than 20*km* offshore were excluded, as were subcrustal events deeper than 35*km*, mostly in subduction areas. Earthquakes with epicentral areas in areas of very low population density or sparsely inhabited regions were also removed.

Figure (6) is a plot of the data for the period 1980-2009. There are *DRE* estimates from 17 countries for 27 earthquakes that plot with the *CPI* almost with a standard error of 0.65. This is a small data base, which is clearly biased towards countries of low transparency, which is to some

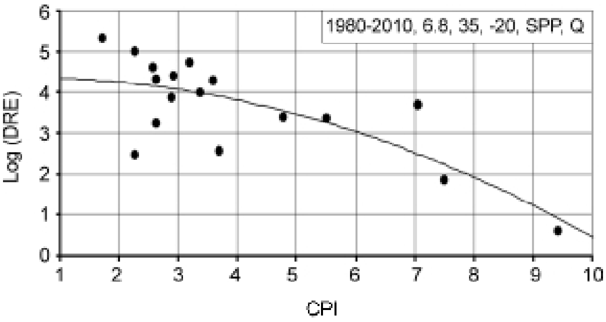

Figure 6. Death toll (DRE) during the period 1980-2009 as a function of the average Corruption Perceptions Index (CPI) over the period 1995-2009, for shallow earthquakes on land of $6.8 \leq M \leq 7.9$.

extent inevitable insofar as most large earthquakes happen to occur in such countries. It confirms, however, that, in spite of the uncertainty in precise numbers even at this low level of discrimination of the various variables involved, the hypothesis that there is an effect of corruption on the number of people killed by earthquakes is valid.

It is obvious that these figures have no predictive value; they simply portray the effect of corruption on the loss of life during the last three decades.

4. Conclusion

It is not just the serious consequences of earthquakes that matter but also the fact that earthquakes that are comparable in size have proportionately negligible effects and that those serious consequences are not inevitable. The data I used are crude and to some degree incomplete; nevertheless, they do show that there is an undeniable relation between corruption and death toll.

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