Editorial

Disaster Financing: A Contingent Valuation Approach

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Abstract

This paper sets out to value the total public financing needed to somewhat alleviate the economic, environmental and social losses of an unprecedented human disaster using a mixed-valuation method, termed 'Contingent Loss Assessment' that integrates the economic loss assessment of the disaster with a contingent valuation of the environmental and social costs.

The focus of the paper is to provide a comparison between the economic predictions of the disaster financing required, and the amount of disaster financing that will better alleviate the human suffering observed, using contingent valuation method (CVM) predictions. Using the case of the 'Lapindo' mudflow disaster in Indonesia, it is argued that the incremental financing required, an extra $200 million flowing directly to those affected, is not an amount that is beyond the scope of those who have undertaken the responsibility of providing compensation to those affected.

Keywords

Mudflow Disaster
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Introduction

Samarco Mineiracoes, a 50-50 joint venture between Australia's BHP Billiton and Brazil's Vale, operates three iron ore mine in Mariana, Brazil. One of the dams burst on November 5, 2015, unleashing 62 million cubic metres of sludge into the Doce River at about 70km/h. It destroyed the town of Bento Rodrigues, killing at least 13 people, displaced thousands of others, affected water supplies to an estimated 250,000 people and killed fish stocks along 600 kilometres of river in two states.

Municipal councils along the river interrupted water treatment and supplies following the accident, causing grassroots campaigns nationwide to collect bottled water for residents. Although some municipalities have said the water is again good to drink, but residents are objecting to its cloudy colour and foul smell.

Samarco, which has been fined 250 million Brazilian reals ($92 million) by Brazil's environmental watchdog, IBAMA, has agreed with the Brazilian government to put R$1 billion ($366 million) into a preliminary fund for compensation and clean-up costs, and risks additional daily fines of R$10 million ($3.7 million) if does not take steps to mitigate the ecological damage. In addition, a lawsuit filed in federal court in Brasilia seeks at least $7.2 billion that would be administered by a private fund over 10 years for environmental recovery and compensation. BHP shares have fallen 20 per cent since the dam burst (Timson and Ker, 2015)

Whilst the economic, environmental and social damage as a result of this disaster is often impossible to measure, it is interesting that within a week of the Brazilian disaster, damage estimates quoting significant monetary values have been calculated and lawsuits filed.

One characteristic common to all natural disasters is that damage estimates calculated shortly afterward tend to be significantly overstated; they are hardly more than just back-of-the-envelope calculations. The factors that contribute to the over-estimation of losses vary considerably. In some cases, buildings, infrastructure and crops that appear totally

destroyed may in fact be only partially damaged. To some extent, this phenomenon is also driven by the media, who like to add a monetary flavour to the disaster. Further, according to some economists who have studied natural disasters, there is also an incentive for Regions to overestimate their losses in order to maximize their political leverage over government and business disaster assistance dollars.

It also appears that the "deep pockets' of BHP have been considered when coming up with the $7.2 billion claim. This is the 'affordability' approach.

Is there a more objective approach? This paper looks at the case of another significant mud-flow disaster, this time in Indonesia, to demonstrate that a 'contingent valuation' approach is more objective than the 'back-of the –envelope' or 'affordability' approaches.

This paper examines the economic, environmental, and social impact of the Sidoarjo (Lapindo or Lusi) mudflow disaster in East Java province. The paper uses a 'contingent valuation method to consider the impact to the East Java economy, the surrounding environment and the people, and the amount of public financing that is required to alleviate the consequential human suffering. The heaviest economic impact has occurred in the region surrounding the mud volcano in Sidoarjo district, but areas to the East and West have also been affected.

This paper sets out to value the total financing needed to somewhat alleviate the economic, environmental and social losses as a consequence of the human disaster known as Sidoarjo (Lapindo or Lusi) mudflow disaster in East Java province, Indonesia. Utilising a mixed-valuation method, termed 'Contingent Loss Assessment' that integrates the economic loss assessment of the disaster with a contingent valuation of the environmental and social costs. The focus of the paper is to provide a comparison between the economic predictions of the disaster financing required, and the amount of disaster financing that will better alleviate the human suffering observed, using contingent valuation method (CVM) predictions.

Lapindo Mudflow Disaster in East Java

On 29th May 2006, mud and gases began erupting from a vent 150 metre from the hydrocarbon exploration well at Lusi. It is not within the scope of this paper to comment on any scientific or other commentary as to the cause of the eruption. The reality is that, now nine years later, the mudflow continues to flow at rates as high as 160,000 cubic metres per day. Dubbed the 'Lapindo mudflow' by most of Indonesia after the company responsible for drilling the well, the mud volcano has inundated an area in excess of 8.5 square kilometres, despite attempts to contain it by constructing a series of embankments.

The mudflow has inundated factories, farmland and the Surabaya–Gempol toll road in the sub-district of Porong. A gas pipeline near the site ruptured and exploded in November 2006, reducing the supply of gas for fertiliser production; this has in turn led to local fertiliser shortages (Plumlee, et al., 2008). Around its centre in Sidoarjo district, the effects of the mud volcano have been particularly devastating. Mud flowing from the volcano has displaced over 50,000 people in more than a dozen villages, severely disrupting their livelihoods. The local property market has collapsed; residents are unable to obtain valuations on their properties. While the impact of the mud- flow has been felt most acutely by the local community in Sidoarjo, other regions in East Java have experienced environmental, logistical and economic effects as a consequence of the disaster.

We have already stated that a characteristic common to all natural disasters is that damage estimates calculated shortly afterward tend to be significantly overstated. This 'instant' overestimation phenomenon does not apply to this study of the lapindo mudflow disaster, as it is being done eight years after the initial occurrence.

Estimating Disaster Losses: An Imprecise Science

Natural disasters typically set in motion a complex chain of events that can disrupt both the local economy and, in severe cases, the national economy. Calculating the damages of

such an event can be an onerous task because the cost of a natural disaster is ultimately wedded to several factors, and, more importantly, varies by type of disaster. Among the key influences are the magnitude and duration of the event, the structure of the local economy, the geographical area affected, the population base and the duration of the impact of the disaster. Naturally, disasters like the Lapindo (Sidoarjo) mudflow disaster that have affected a densely populated area for a long period of time have the greatest potential for inflicting the most damage. Not only are large numbers of people endangered, but the potential loss to homes, businesses, highways, roads, bridges and utilities is also magnified.

It must be noted that, in an economic sense, the *cost* of a natural disaster and the *losses* that stem from a natural disaster are two separate terms. 'Losses' occur principally through destruction of an economy's wealth; i.e. the physical assets that help generate income (see Table 1). These assets include roads, homes, buildings, bridges, levees, utilities, factories, farmland, forests or other natural resources. To correctly measure these losses, one must attempt to calculate either the lost income that these physical assets help generate, or the decline in the assets' values. To count both is to double count. By contrast, 'costs' are incurred when an economy undertakes to replace, repair or reinforce those tangible assets (capital) that are destroyed; this includes the buttressing of structures beforehand (for example, the construction of levees or seawalls, or the reinforcement of bridges or buildings in earthquake prone areas); or in the case of the Sidoarjo mudflow disaster, the diversion of the mudflow; and the repairs and reconstruction of roads, factories and houses away from the disaster area.

Disaster losses manifest themselves in numerous ways, and, unfortunately, can never be estimated with absolute certainty. When correctly calculating losses, an analyst must account for several factors that are often overlooked, intertwined or extremely difficult to measure.

For example, how do you determine the true value of a containment bund, levee, a public road or a sewage treatment plant? Economists believe that the true value of a physical asset is its present discounted value, but calculating this value involves a degree of subjective judgment. A structure's market value is probably the next best alternative, but this measure also presents problems because some physical assets are not traded in the marketplace; thus, determining their true market value is next to impossible. Therefore, for lack of reliable information, analysts often use the asset's replacement cost. Endless other issues also arise. How do you measure the decline in property values that sometimes occurs in the vicinity of the disaster area? What prices and production should you attach to crops that were washed away before harvest, or livestock that were unable to gain weight during severe weather? Finally, how do you calculate the expected lifetime earnings of individuals who perished?

Despite these limitations, economists attempt to measure the total loss of a disaster by estimating two separate types of losses: direct and indirect. Direct losses are easier to estimate. For example, in the Lapindo mudflow disaster, these losses would consist of the crops, buildings or structures that were destroyed or damaged as a result of the mudflow.

Indirect (or secondary) losses are the consequences of the direct losses. These include lost output, retail sales, wages and work time, additional time transporting goods or commuting to work (reduced leisure), additional costs to business from rerouting goods and services around the affected area, utility disruptions, reduced taxable receipts, lost tourism or increased financial market volatility. Obviously, calculating indirect losses is the more difficult of the two.

It must be remembered that the losses and resultant economic consequences shown in Table 1 all pertain to physical assets and the economic consequences of losing the use of those assets due to the disaster. However, it is not possible to value the full longer-term impact of the disaster on the ecological systems and social networks using market-based loss assessment techniques. As such, these valuations need to be complimented by other 'non-market' valuation techniques.

Table 1: Calculating the Economic Effects of Natural Disasters: Some Definitions and Concepts

Term	Definition	Example
Losses	Change in wealth caused by damage to structures or other physical assets	Houses, buildings and structures are damaged, crops and forests destroyed, landslide damages
Direct vs. Indirect Losses	Direct losses are those resulting from building, lifeline, and infrastructure damages. Indirect losses are those that follow from the physical damages.	Direct losses: building damages, bridge collapse, loss of lives. Indirect losses: commuter disruptions, loss of local tax revenues, reduced tourism
Market vs. Non-market Effects	Market effects are those that are reflected in national income accounts data; Non-market effects do not appear in the national income accounts data	Market effect: loss of income due to disaster-caused destruction. Nonmarket effects: loss of leisure time due to longer commute as a result of the disaster.
Costs	Highest-valued of foregone alternative use of a resource	Mitigation expenditures undertaken before the disaster occurs, (for example, construction of levees or seawalls or reinforcement of buildings) and reconstruction of buildings, etc. during recovery period
Redistribution	Transfer of wealth between individuals or governments	Federal disaster relief, but also includes transfers that occur because resources or production are moved to a new region
Wealth	Present value of the income stream from the productive assets of society	The value of a forest or farmland is the sum of the flow of monetary benefits (income from sales of timber or crops) and non-monetary benefits (vistas and recreational benefits of a forest)

Source: Adapted from Brookshire and McKee (1992).

The Contingent Valuation Method

The *Contingent Valuation Method* (CVM) is used to estimate economic values for all kinds of ecosystems and environmental and social attributes. The method has great flexibility, allowing valuation of a wider variety of non-market goods and services than is possible with any other non-market valuation technique. It can be used to estimate both *use* and *non-use* values, and it is the most widely used method for estimating non-use values. It is also the most controversial of the non-market valuation methods, and some of these controversies will be discussed later.

The CVM involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services. In some cases, people are asked for the amount of compensation they would be willing to accept to give up specific environmental services. It is called "contingent" valuation, because people are asked to state their willingness to pay (or receive as compensation), contingent on a specific hypothetical scenario and description of the environmental service.

The CVM is referred to as a "*stated preference*" method, because it asks people to directly state their values, rather than inferring values from actual choices, as the "*revealed preference*" methods do. It circumvents the absence of markets for environmental goods by presenting consumers with hypothetical markets in which they have the opportunity to pay for the goods/services in question, or receive as compensation for foregoing such. The hypothetical market may be modelled

after either a private goods /services market or a political market.

The fact that the CVM is based on what people say they would do, as opposed to what people are observed to do, is the source of its greatest strengths and its greatest weaknesses. CVM is one of the only ways to assign dollar values to non-use values of the environment and of society - values that do not involve market purchases and may not involve direct participation. These values are sometimes referred to as "passive use" values. They include everything from the basic life support functions associated with ecosystem health or biodiversity, to the enjoyment of a scenic vista or a wilderness experience, to appreciating the option to fish or bird watch in the future, or the right to bequest those options to your grandchildren. It also includes the value people place on simply knowing that giant pandas or whales exist. In a social context, it places value to aspects such as good health, sound education, public safety, freedom of speech, etc.

It is clear that people value non-use, or passive use, environmental and social benefits. However, these benefits are likely to be implicitly treated as zero unless their dollar value is somehow estimated. So, how much are they worth? Since people do not reveal their willingness to pay for them (or receive compensation for foregoing them) through their purchases or by their behaviour, the only option for estimating a value is by asking them questions.

However, the fact that the CVM is based on asking people questions, as opposed to observing their actual behaviour, is the source of enormous controversy. The conceptual, empirical, and practical problems associated with developing dollar estimates of economic value on the basis of how people respond to hypothetical questions about hypothetical market situations are debated constantly in the economics literature. CVM researchers are attempting to address these problems, but they are far from finding acceptable solutions. As a result, many economists, psychologists and sociologists, for many different reasons, do not believe the dollar estimates that result from CVM are valid. More importantly, many jurists and policy-makers will not accept the results of CVM. Because of its controversial nature, users must be extremely cautious about spending money on CVM studies and about using the results of CVM studies. [See Appendix 1 for a summary of the *Advantages* and *Limitations* of the CVM approach.]

Contigency Indicators

The list of contingency indicators is structured around the three broad categories: economic, environmental and social. They are first indicated in monetary or non-monetary terms, and then if the effects are direct or indirect (see Table 2). *Direct impacts* are due to direct contact with disaster, i.e. an immediate effect. *Indirect impacts* occur as a result of the direct impacts, and have a medium to long term effect. *Monetary Impacts* have a market value and will be measured in monetary terms whilst *Non-monetary impacts* are non-market impacts, such as health impacts.

Economic impacts are usually grouped into three categories: direct, indirect, and macroeconomic (also called secondary) effects. Direct economic damages are mostly the immediate damages or destruction to assets or "stocks," due to the event itself. A smaller portion of these losses results from the loss of already produced goods. These damages can result from the disaster itself, or from consequential physical events, such as fires caused in the aftermath of Lapindo disaster by gases escaping. Effects can be divided up into those to the private, public and economic sectors: In the private sector, the loss of and damage to houses and apartments and building contents (for example, furniture and household equipment) is an effect. In the public sector education facilities such as schools, health facilities (hospitals) and so-called lifeline infrastructure such as transport (roads, bridges) and irrigation, drinking water and sewage installations as well as electricity. In the economic sectors, there are damages to buildings, machinery and other productive capital. Another category of direct damages is the extra outlays via the Government (taxpayer) and the general public donations on *emergency spending* in order to help the population during and immediately after a disaster event. All of these direct economic damage categories were present in the Lapindo mudflow disaster.

The direct stock damages have indirect impacts on the "flow" of goods and services: *Indirect economic losses* occur as a consequence of physical destruction affecting households and firms. Most important indirect economic impacts comprise: (1) diminished production/service due to interruption of economic activity; (2) increased prices due to interruption of economic activity leading to a reduction of household income; (3) increased costs as a consequence of destroyed roads, e.g. due to detours for distributing goods or going to work; and (4) loss or reduction of wages due to business interruption. Indirect effects represent how disasters affect the regular way of living and undertaking business.

Assessing the *macroeconomic (secondary)* impacts involves taking a different perspective and estimating the aggregate impacts on economic variables like gross domestic product (GDP), consumption and inflation due to the effects of disasters, as well as due to the reallocation of government resources to relief and reconstruction efforts. As the macroeconomic effects reflect indirect effects as well as the relief and restoration effort, one must be careful not to simply add these effects to the direct and indirect effects as they are partially accounted for by those already, and this will cause duplication.

Clearly, in any disaster, the environmental and social consequences also have economic repercussions. The reverse is also true since loss of business and livelihoods can affect human health and well-being. From an anthropogenic perspective, the environment may have a *use* and *non-use* value. The *environment* can be regarded as a provider of goods and services for human consumption: food, recreation, maintaining biodiversity, etc. Water for consumption or irrigation purposes, soil for agricultural production are good examples of use value. These impacts should be included in the valuation of loss impacts. On the other hand, there are also non-use values such as option value (the environment may have future value either as a good or a service), existence value (value of knowing a certain species exists)), and bequest value (knowing that something will exist for future generations). Effects on biodiversity and natural habitats fall into this category where there is not a direct, measurable benefit, but ethical or other reasons exist for protecting these assets and services. This is more difficult to measure in terms of monetary loss impact. Some use values-and those impacts on those values- such as environment as provider or goods in agriculture will/should be included in the economic impacts. As a general proposition, the valuation of environmental impacts is highly case specific, and default values (such as for the health impacts) have to be obtained using contingent valuation methods.

It must not be forgotten that disasters, natural or man-made, may also have *positive* effects; such as an increase of pasture area for raising livestock, increased water availability or replenishment of aquifers; or the sudden influx of relief funds from private and public sources to alleviate suffering. Such funds can be used to boost the construction sector (resulting in a post-event reconstruction boom). However, there were no significant positive effects in the Lapindo mudflow disaster. The only real construction was the rebuilding of the alternative road and a construction of some factories and houses in an adjacent area. In the valuations done in this paper, as the adverse impacts of the Lapindo mudflow disaster by far overshadowed the positive effects, the positive effects were not listed separately in the valuation.

The *social* impacts of a disaster may affect individuals or have a bearing on them at the societal level. These can also be categorised into direct and indirect effects. The most relevant *direct social effects* are: (1) the loss of life; (2) people injured and affected; (3) loss of important memorabilia; and (4) damage to cultural and heritage sites (in addition to the monetary loss). The main *indirect social effects* are: (1) increase of diseases (such as cholera and malaria); (2) increase in stress symptoms or increased incidence of depression; (3) disruption in school attendance; and (4) disruptions to the social fabric such as the disruption of living environments and the loss of social contacts and relationships.

Table 2: Summary of Quantifiable Disaster Impacts

	Monetary		Non-Monetary	
	Direct	***Indirect***	***Direct***	***Indirect***
Economic				
Private sector: Households	Housing damaged or destroyed	Loss of wages, reduced purchasing power		Increase in poverty
Public sector*:* Education: Health; Water and Sewage; Electricity; Transport; Emergency Spending	Assets destroyed or damaged: buildings, roads, machinery, etc.	Loss of infrastructure services		
Economic Sectors: Agriculture*;* Industry*;* Commerce*;* Services	Assets destroyed or damaged: buildings, machinery, crops etc.	Losses due to reduced production		
Environmental				
			Loss of natural habitats	Effects on biodiversity
Social				
Households			Number of casualties; Number of injured; Number affected	Increase of diseases; Stress symptoms
Source: Richards (2011)				

The Application of the Contingent Valuation Method

The researchers followed the steps required in the CVM process over the period March 2011-August 2012. The first step was to define the valuation problem. This included: (1) identifying interested parties and stakeholders; (2) determining exactly the services and issues were to be valued, and (3) who the relevant population was. This involved examining the disaster area to be valued; the goods and services affected, and the ecological and social issues involved.

The second step was to have preliminary decisions about the CVM survey with key academics in universities in the area and other stakeholders including local councils and the affected population. The stakeholders of the Lapindo mud disaster were identified as: (1) the company *(Lapindo);* (2) one regency (*kabupaten*); (3) the regent *(bupati);* (4) four sub-districts (*kecamatan*); (5) 15 villages *(desa);* (6) 10 factories *(pabrik);* (7) 300 small businesses; (8) three health centres (*puskesmas*); (9) 33 schools (10) lawyers; (11) NGOs; (12) security/police; and (12) the media. This survey was contingent on the importance of the valuation issue and the complexity of the questions being asked. In-person interview were used extensively since this is regarded as the most effective method for complex questions, because it is often easier to explain the required background information to respondents in person, and people are more likely to complete a long survey when they are interviewed in person. Often colour photographs were used to help respondents understand the conditions of the scenario that they were being asked to value.

After these preliminary decisions, the next step was the actual survey design. This was the

most important and difficult part of the process, and took six months to complete. It was accomplished in several steps. The survey design process started with initial interviews and/or focus groups with the types of people who were directly or indirectly affected by the disaster. In the initial focus groups, the researchers asked general questions, including questions about peoples' understanding of the issues related to the site, especially whether they are familiar with the wider environmental and social issues.

In later surveys and visits to the disaster site, the questions got more detailed and specific, and helped develop specific questions for the survey; especially the kind of background information that was needed and how to present it. This involved obtaining information on the location and characteristics of the site both through research and observation. The researchers also wanted to learn about peoples' knowledge of relevant environmental and social issues at this stage, test different approaches to the valuation question. Also different payment/compensation mechanisms were tested. Questions that can identify any "protest" bids or other answers that do not reveal peoples' values for the services of interest were also developed and tested at this stage. A number of these in-depth interviews were video recorded.

The next step was the actual survey implementation. This also required five visits to the disaster site to select the survey sample and conduct the interviews. At one of the visits, there was a demonstration by affected villagers, and over 100 personal interviews were conducted. Samples of these responses are provided in the paper. Secondary data was also collected on economic loss assessment for integrating these with the CVM calculations. The final step; i.e. to compile, analyse and report the results using loss assessment and contingent techniques appropriate for this type of study are presented in this paper.

Economic Impact

The mudflow has had a marked impact on the province's economy and business sector. The disaster has brought about social and economic losses to the people in the Lapindo Regency and surrounding regions and also impacted on businesses and business confidence. The region suffering the biggest loss is the central corridor from Surabaya south to Malang, which constitutes East Java's manufacturing heartland (Santosa and McMichael 2004). This region, known as the growth ribbon (pita pembangunan) of East Java comprises the districts of Lapindo, Mojokerto, Pasuruan and Malang. The economic costs generated by the mudflow are likely to continue to grow substantially. Eight years after the disaster, the scale of the human tragedy is still unfolding as seen from these are two typical responses from members of Jatirejo village, which was 5 kms from the mudflow spray area.

There were hundreds of farms, rice fields and small businesses and 10 large factories directly affected by the mudflow, adversely affecting the lives and livelihoods of thousands of people. In addition to the direct impact (destruction, inundation) there has been an indirect impact on many more businesses in East Java.

In terms of logistics, it is estimated that before the mudflow the Surabaya–Gempol toll road accommodated 20,000–30,000 vehicles per day, including up to 3,000 container vehicles (Yahya 2007). Despite co-ordinated efforts, this toll road was overwhelmed by the mud. This has heightened congestion on secondary roads, especially disrupting the flow of goods and people from Surabaya to the city of Malang and to regions to the east and south of Malang. Transportation times have increased for freight.

The additional time needed to transport goods to a Port or obtain deliveries of locally sourced materials implies a considerable financial burden for many companies in terms of the extra fuel used, the overtime paid to trucking operators and the requirement to pay illegal levies for the use of secondary roads. For some shippers, late delivery of goods to the container terminal at Surabaya has incurred additional demurrage costs of up to Rp 600,000 (US$ 60) per container. It has been estimated that the mudflow has, on average, increased transport costs for individual manufacturers by 30%, and one Lapindo-based housing tile manufacturer claims that costs have increased by 50–60% for its raw

materials sourced from the Malang region (McMichael, 2009).

The economic impact of the mudflow is unevenly spread through the province. In Lapindo, the mudflow has had a direct impact, with economic growth in the district falling from 6.7% in 2005 to 4.6% in 2006. The leather processing, food, and hotels and restaurants sectors have been most affected. The closing of a main toll road has also affected the micro-traders who serviced the traffic flow.

In Tanggulangin sub-district, it is estimated that output from the flourishing leather industry dropped by 80% after the appearance of the mud volcano (McMichael, 2009). The mudflow has undermined Lapindo's ranking as an exemplar of economic growth and public service (Setiadi, 2007). Given that 20–30% of East Java's exports and imports originate in, or are destined for, factories in Lapindo, the likelihood that the district's economy will remain weak for some time is of particular concern (Yahya, 2007). Unfortunately, a shadow economy has replaced the traditional economies in the area. Local tourism of Indonesians coming to see the disaster area has boomed. Many ex-factory workers have become tour-guides on motor-cycles. The women have taken to the oldest profession that often goes hand-in-hand with tourism.

The economy of the Malang district has also been hard hit by the effects of the mudflow. Growth in the furniture sector declined from 7.2% in 2005 to 5.3% in 2006 (Ananda, 2007) and has continued to decline. Hotels in tourist centres in Malang and in Trawas and Prigen on the northern slopes of Mt Arjuna experienced declines of up to 80% in occupancy rates at the onset of the mudflow, but appear to have recovered somewhat since then, due to the Indonesian local tourism that has come to see the disaster. Surabaya trucking firms and clove and cigarette manufacturers in the Malang area have been particularly affected by disrupted distribution channels. The downturn in the handicraft industry has transferred Malang's competitive advantage in that sector to neighbouring Tulungagung, a traditional competitor of Malang. Regions to the west of the central corridor have been affected by the infrastructure and the transport bottleneck around Surabaya that resulted from the mudflow.

The degree to which the mudflow has affected individual manufacturing enterprises in East Java appears to be related to the scale of their logistics and distribution networks. For example, in the Probolinggo district, the fish canning industry has suffered financial losses stemming from the increased trucking distances required to transport goods to Surabaya. Similarly, seafood exporters using cold storage facilities in Pasuruan district have had to bear additional freight costs to move their product to the port of Surabaya for export. By contrast, cane sugar production has been little affected, because of that industry's reliance on local processing and distribution and the use of small trucks to transport cane over secondary roads.

Larger manufacturers with more diverse distribution networks have been less disadvantaged than their small and medium enterprise counterparts. One of the jewels in the Province's economic crown is the clove (kretek) manufacturer, PT Gudang Garam. The company employs a workforce of 41,000 in Kediri and generates nearly a third of the district's local tax revenue. Gudang Garam's output and distribution has not been affected significantly by the mud flow and believes that where it is concerned business confidence in Kediri remains strong (McMichael, 2009).

Individual firms have found means of accommodating their business operations to the difficult circumstances wrought by the mudflow. For example, the bottled water manufacturer PT Ades Waters Indonesia, a subsidiary of PT Aqua Golden Mississippi (Danone Group), sources its raw material from springs in Pandaan and has relocated its packaging plant to Surabaya to reduce transport costs. Leather handicraft companies from Tanggulangin village, situated near the source of the mudflow, have joined together to open exhibition halls in Surabaya as a means of obviating the need for prospective buyers to travel to the mud affected area. Also, the East Java government has taken concrete measures to assist industries affected by the mudflow, including the establishment of a new trade centre in Mojokerto to showcase handicrafts

Table 3: Direct Economic Costs - 2006 - 2015 (US$)

No.	Cost Component	2006	2007-2015*	Total
1	Lost Assets	131,467,000	1,729,972,000	$1,861,439,000
2	Lost Income	16,736,000	215,547,000	232,283,000
	Total	**148,203,000**	**1,945,519,000**	**$2,093,722,000**

**Future Cash Flows Discounted to Present Values (2011) using a 15% Discount factor*

Source: Brawijaya University Report on Economy Impacts Assessment of the Mud Flow 2006

Table 4: Indirect Economic Cost - 2006-2015 (US$)

No.	Cost Component	Economic Cost*
1	The Decrease of the Value of the Asset	$459,696,840
2	Decrease of Bus Income	1,500
3	Decrease of Small Bus Income	230
4	Decrease of Truck Income	1,200
5	The Increase of Cost for Private Transportation	5,700
6	The Decrease of the Hotel Income	5,570
7	The Decrease of Restaurant Income	1,530
8	The Decrease of the Trade Income	2,210
9	The Decrease of the Fish Pond Owner Income	288 ,890,530
10	The Increase of the Cost Of Maintaining The Porong River	13,200
	Total	**$748,618,510**

** Future Cash Flows Discounted to Present Values (2011) using a 15% Discount factor*

Source: Brawijaya University Report on Economy Impacts Assessment of the Mud Flow 2006

Table 5: The Economic Cost for Recovering the People in Inundated Area - 2006-2015 (US$)

No.	Cost Component	Cost*
1	Increase of The Cost to Recover the Area	$281,017,000
2	Increase the Cost to Recover the Business	89,452,000
3	Increase in the Cost to Recover the Public Infrastructure	218,917,000
	Total	**$589,386,000**

**Future Cash Flows Discounted to Present Values (2011) using a 15% Discount factor*

Source: Brawijaya University Report on Economy Impacts Assessment of the Mud Flow 2006

and leather goods manufactured in the Lapindo area. It should be recognised that, aside from the mud volcano, a wide range of factors have a bearing on the rate of economic growth in the province. For example, regulatory barriers to domestic trade in East Java are a significant obstacle to business sector growth (World Bank and The Asia Foundation, 2005). Inadequate transport infrastructure (especially in the rail network), a chronic shortage of reliable power for industry and rising electricity tariffs are acknowledged as impediments to domestic and foreign investment. Moreover, a lack of clarity in government decision making with respect to mudflow compensation and reconstruction arrangements has had a negative impact on local business confidence.

These economic losses and financial costs are provided in Tables 3 to 5 and are summarised from the Brawijaya University Report on *Economy Impacts Assessment of the Mud Flow 2006* (BPK – RI, 2007, Richards, 2011). It was not the purpose of this research study to recalculate the economic cost despite the new evidence emerging from the CVM interviews, and therefore the numbers are used in this loss assessment uses these economic costs as a starting point.

Please note that in expressing expected future costs and benefit streams in present value terms, discounting is required. Discounting is undertaken as people put a higher value on the present, funds invested now offer profit opportunities in the future (thus, there are so-called *opportunities costs* to using funds for other purposes) and there is generally uncertainty about the future. The discount rate represents the average return of a public investment into alternatives projects; e.g. a discount rate of 12% signifies that investing public funds (into water infrastructure, health, education etc.) on average would bring about a return of 12% and other projects would need to have at least an equal return in order to be considered. Often a discount rate of 12% is chosen in practical applications for the calculation of the NPV, e.g. standard used by Asian Development Bank (ADB 2002). In Tables 3-5 however, a 15% discount factor was used to adjust for country-specific risk by Brawijaya University, and this is also used for the contingent valuations.

Environmental Impact

The Lapindo mudflow is a new type of disaster, one that involves both man-made activity and natural phenomena. The duration of this disaster is estimated to be 23–35 years, much longer than other types of disaster—earthquakes last seconds; tornadoes, minutes; tsunamis, hours; floods, days or weeks.

In order to minimize the impact of the mudflow, the mud should ideally be released to the sea via the Porong River. However, the high viscosity of the mudflow and geological deformation such as land subsidence constrain the mitigation process. Hence, land subsidence has made the mudflow's pools become lower than the river, and the high viscosity of the mud has made it harder for it to flow naturally through hydraulic mechanisms. Furthermore, the accumulation of mud in the river is causing sedimentation through the riverbank and spreading across the fisheries' aquaculture area along the coast. The local Marine and Fisheries Board stated that if the mudflow cannot be appropriately released to the sea, the sedimentation will affect the quality of the water's oxygen absorption in the river and estuary. This would disrupt 1,500 hectares of traditional shrimp aquaculture in the area.

Mudflow eruptions are associated with the release of bubbles and toxic gas. Some bubbles comprising a mixture of gases and water have been found in residential areas. Some of these reached 15 meters in height. Moreover, toxic gases, such as hydrogen sulphide (H2S), have been released from the mudflow's epicentre. The Ministry of Environment in Indonesia stated that on the first day of eruption, H2S levels reached 700 parts per million (ppm), which can be deadly to humans. The Research and Development Agency of the Ministry of Public Works stated that fresh water quality surrounding the mudflow area is unsuitable for consumption; for example, the turbidity level reached 47-169 NTU, where 25 NTU is the maximum for safe consumption (Richards, 2011).

The accumulation of mud from the original vent is accompanied by subsidence in the surrounding area. It has been projected that more than 40 metres of subsidence will occur in the next few years within several kilometres

of the eruption vent. The possibility exists that a huge crater will form from the hollowed-out remains of the mud volcano. Dried mud deposits could have adverse effects on river and marine environments and on the health of local residents (Plumlee, et al. 2008).

Another cause for concern is the mud's impact on natural drainage patterns in the Brantas River basin. Mud-induced siltation of the Porong River is expected to heighten the risk of wet-season flooding in the vicinity of Mojokerto and Lapindo. If flood-waters cannot be contained upstream, it is feared the Surabaya River will overflow, leading to possible widespread flooding in Surabaya (Rumiati, 2007). Evidence is mounting that the mud has a harmful impact on river ecosystems and human health. The mud has been assessed as containing phenol in concentrations exceeding the maximum residue limit (Friends of the Earth International, 2007). Phenol is toxic to fish, aquatic vegetation and humans. A recent report by the United States Geological Service has found that several elements, notably arsenic, are present in concentrations that exceed US government environmental guidelines for residential soil (Plumlee, et al. 2008). It can be assumed that the mud will seriously affect the livelihoods and health of shrimp and fishing communities located adjacent to the Porong River and the Madura Strait, that is, communities in the districts of Lapindo, Madura, Pasuruan and Probolinggo, and the municipality of Surabaya.

With attempts to staunch the flow totally unsuccessful, plan has been devised for its long-term management. A United Nations Environment Programme (UNEP) evaluation in June 2008 identified three mitigation options: pumping the mud directly into the sea (at a cost of Rp 13 trillion over 30 years); pumping the mud to mangrove wetlands to the east while diverting the Porong River (at a cost of Rp 16 trillion over 30 years); and, most expensively, constructing an open channel to allow mud to flow directly to the sea (a one-off cost of Rp 33 trillion) (UNEP, 2008). None of these options is risk-free: with the first, there is concern that pumping would not be able to move the required volume of viscous mud; the second increases the risk of flooding; and the third would impinge on production in farming and aquaculture areas.

Initially the Lapindo Company was held responsible for managing all the economic, environmental and social issues within the affected area. These are summarised in Table 6. As such, the Lapindo Company was also initially responsible for mudflow prevention efforts including the management of the main levee and drainage of the mudflow to the Porong River. However, the responsibility for the management of the mudflow was given to an agency called *Badan Penanggulangan Lumpur Lapindo (Lapindo Mud Management Agency)* or BPLS through the Presidential Regulation 14/2007. This was a positive step in the process, as the Lapindo Company was clearly not equipped with the expertise to effectively manage such a monumental task. In addition to their other extremely difficult task of containing and managing the mud flow, BPLS has a comprehensive role in managing the social issues in the Lapindo region as they relate to the mud volcano disaster. The areas of responsibility attributed to BPLS through the Presidential Regulations were brought about as a result of consultation between affected residents and Governments at all levels.

The BPLS tries to continually consult and coordinate with the provincial governments of East Java and the Lapindo regency government. Also the local governments each have a member on the BPLS Advisory Board. Local governments have a very important and diverse role to play in the Lapindo mud disaster, both in managing social problems as well as in procuring land for the relocation of infrastructure. Examples of the roles local government takes in managing social issues are: (1) the provision of temporary shelter to the displaced population in the PBP refugee camp; (2) opening of the community health posts; (3) transportation assistance for school children whose parents have sought refuge in the PBP refugee camp; (4) information dissemination, mediation, and one on one help in the form of clarification of issues and consultation with the affected population; (5) assistance to farmers for crop failure; (6) provision of water tanks in some villages with polluted groundwater.

The environmental issues that have a social consequence are (1) the social impacts experienced by residents, including a

community development role in the mudflow prevention activities; (2) the social impacts arising as a consequence of geological deformations such as bubbles (eruptions of gas / water / mud) that threaten the safety of residents, as well as the pollution of soil and irrigation water; and (3) the evacuation and relocation of affected residents to a safer place. The BPLS is also responsible for compiling information that will assist in forming a basis for future policy direction in managing social issues. Clearly the environmental disaster had a significant social consequence. This will now be examined in the next section.

Social Impact

As discussed before, initially the Lapindo Company was held responsible for managing all the economic, environmental and social issues within the affected area. These are summarised in Table 6. Later, this management task was handed over by Presidential Regulation to the BPLS that consisted of a number of agencies including the (1) National Land Agency Regional Office of East Java; (2) East Java Regional Police and Lapindo Police; (3) Lapindo Land Office ; (4) (5) Lapindo District Attorney; (6) Lapindo District Development Planning Agency; (7) Village representatives (i.e. Sub-District Head in the Three Districts and 12 Village Chiefs); and the (8) Lapindo company (amongst others).

BPLS split their responsibilities for social management into three main areas. These are Social Assistance, Social Protection and Social Recovery. BPLS defined social assistance as being; *intended to reduce the social impact in an emergency, whether that occurs because of the impact of a blast or as soil degradation and to implement a precautionary measure as a form of preparedness in case of disaster*. It is in relation to these issues, and the benefits and costs involved, that the contingent valuation approach used in this paper focused on.

Social Assistance: BPLS has five (5) main areas of responsibility in relation to their social assistance program. These are to (1) supervise the provision of social assistance; (2) carry out monitoring and implementation of the evacuation of mudflow victims; (3) provide social assistance based on the Presidential regulation 48 / 2008; (4) provide water aid; and (5) set-up empowerment (training) programs for re-skilling displaced workers.

In terms of the first responsibility, the social assistance provided to affected villagers is to be in terms of (1) life insurance (2) evacuation payment for families and (3) house rental contract monies. These amounts are listed in Table 6. However, an overwhelming majority of those interviewed in 2011 and 2012 were either unhappy with the quantum, or the delay in payment, or both. In terms of the second responsibility, a majority of these evacuees went to the New Market evacuation centre in Porong (PBP). These refugees included permanent residents and a number of seasonal residents. Here, it was clear that whilst the BPLS believed that these refugees were, in the main, willing to move from the PBP after receiving social assistance, again those affected felt that this assistance in the form of cash, home contracts, life insurance and moving expenses (seasonal residents are not given life insurance assistance) was woefully inadequate. The amounts agreed to are given in Table 6, and the comments from the interviewees indicated a significant level of dissent.

In terms of the third responsibility**, s**ocial assistance as mandated by Presidential Regulation 48/2008 is to provide assistance to residents in 3 villages namely Besuki, Kedungcangkring, and Pejarakan. The government's plan was to use the land within the area of these villages as mud storage ponds. This is where mud and water is stored before being discharged into the Porong River. The social assistance took the form of payment for home rental assistance, moving expenses and life insurance. Over 1600 families from these villages were provided with grants totalling around Rp 5 billion (US$500,000). Despite this, there appears to significant hardships faced by the victims, indicating that a large quantum of this money has not trickled down to the actual victims. This is very typical in many disaster areas, where thirds parties (including, Aid Agencies, Missionaries, NGOs) skim over 80% of the monies for ‘administration’. Of course, corruption can also be a major factor.

In terms of the fourth responsibility**,** many clean water sources for residents surrounding the disaster area were polluted or damaged by the eruption and mud flows. As a result BPLS was also tasked with providing residents in 12 villages with clean water intended at a rate of 20 litres per person per day. Again, there was a separation between perception and reality with many interviewees complaining that they did not have proper water for some time as they were allocated 20 litres per person per day for all daily needs including cooking; washing and drinking.

In terms of the fifth responsibility, a number of programs have been initiated to enable refugees and those affected by the disaster to improve their lives by learning new skills. Examples of this training includes: shoe making, food processing, and carpentry. But the new skills taught, and the numbers actually retrained has been very low. Often, the training is in repetitive blue collar work. This has not sat well with people who had more job flexibility such as farmers. Even former factory workers have complained about these new skills.

Social Protection: The principal activities of the Social Protection program are the protection of affected citizens' rights with respect to property that is lost or damaged due to the impact of the mudflow. This protection is supposedly provided within the framework of the implementation of compensation through the sale and purchase of land and buildings , compensation for loss of income caused by the loss of equipment, jobs, farms or because businesses can no longer continue. BPLS have six (6) main areas of focus with respect to the social protection area. These include: (1) supervision and facilitation of the sale and purchase of affected land and buildings; (2) monitoring and facilitating compensation for failed harvests; (3) compensation for companies that have been forced to cease operating; (4) coordinate compensation for small and medium enterprises (SMEs); (5) managing rallies; and (6) refugee management in new market Porong.

Focus areas 1- 4 cover economic issues and these are summarised in Table 6; and have been covered in earlier discussions. However, as we know, economic hardships have a direct bearing on social costs.

Focus areas 5 – 6 encompass wider issues. Many demonstrations and rallies have been carried out by affected residents over the years since the first eruption. This is of course completely understandable and indeed within their rights in a democratic Indonesia. However with tensions running high due to the scale and nature of the losses experienced and the complexity of the compensation system; some demonstrations have the potential to turn violent and/or destructive. BPLS take on the responsibility to ensure that demonstrations and rallies remain peaceful. They do this by forming a network of cooperation with relevant parties in order to coordinate, monitor, or mediate as the situation requires. BPLS hopes that its involvement makes it easier for affected residents to deliver their demands directly to the Lapindo Company.

In addition to the steps above, BPLS also conducts meetings or makes informal approaches to the representatives of affected citizens to give various explanations or receive clarification regarding their demands or grievances. This is intended to avoid the need for demonstrations and to achieve the desired outcomes for all the parties through negotiation rather than confrontation. However, the researchers attended many rallies at the Lapindo site and found no representative of the BPLS present, and many interviewees claimed that they were, in fact, completely ignored. The only third-party (other than the protesters) encountered by the researchers was the security of the Lapindo Company.

In terms of refugee management, the BPLS has had the difficult task of consulting with, negotiating, and persuading refugees to agree with the compensation packages offered and submit claims in accordance with Presidential Regulation No. 14 / 2007 to the verification teams where appropriate. As a result of this consultation the refugees in PBP began to become more cooperative and willing to participate in the compensation process. In July 2008 more refugees began to submit claims to the verification teams and agreed to move from the camp once the initial 20% payment was made by the Lapindo Company.

However, when the Researchers visited the Lapindo site in 2011, 2012 and 2014, many claims submitted in 2008 had still not had an outcome, and a groundswell of resentment was emerging.

Social Recovery: The Social Recovery area focuses primarily on the areas of: (1) emotional stress caused by the loss of homes and livelihoods; (2) general and remedial education; (3) environmental factors; (4) general health of the population; and (5) the dissemination of useful information. The BPLS Social Recovery team's goals are to assist people to better deal with the emotional stresses and go back to being a happy and productive member of their society, and to ensure the people have adequate information, education and counselling to deal with these issues.

The greatest need identified by BPLS within the groups that they deal with is for more information and more discussion surrounding the sale and purchase of land and buildings in Pejarakan, Kedungcangkring, and Besuki. The BPLS is also responsible to monitor and respond to the dynamics of environmental change, the movement of individuals and communities and general social changes and issues that occur. However, although the BPLS believes that the information regarding these issues is distributed widely regarding clean water issues, personal empowerment and counselling services; this was not the view from those interviewed.

In terms of assisting in education issues, the BPLS assisted school children from displaced families in New Porong market to get to school. Also, adult education in the affected area has been sporadically provided over the last eight years so that people have access to information regarding claims and a forum for airing complaints and concerns. BPLS has also facilitated meetings between representatives of education foundations / boarding schools and the Lapindo Company. But as indicated from many interviews like the above, there is much 'noise' and the official channels of communication often break down.

Managing emotional and spiritual problems is aimed at early detection of emotional instability disorders within victims. Groups of volunteers, both psychiatrists and psychologists and counsellors, have donated their time and expertise to help deal with these problems. In addition, BPLS has also been carrying out social healing sessions with individuals and small groups of residents who have indicated that they are experiencing emotional issues. The contribution of these volunteers and the better understanding of emotional problems have led to the improvement of the emotional state of residents. Lastly, in the area of empowerment the BPLS arranges skills training for victims allowing them the opportunity to gain meaningful employment (which has been already discussed). Whilst these are moves in the right direction, eight years after the mud disaster, there still are significant emotional and spiritual issues to resolve.

The Predicted Financing Requirements of the Disaster

Unlike many other types of disasters like earthquakes and tsunamis where there is significant loss of life immediately, the Lapindo mudflow has no loss of life due to the disaster itself. In those other types of disasters, the consequent loss of life due to despair and depression was often double the original toll. It is very likely that the Lapindo mudflow has had a similar loss of life due to emotional distress.

However, official numbers recording this is sparse. It was clear from the interviews, however, that these numbers were high, and likely to increase; the more the promised compensation is delayed. Table 6 summarises, as best as possible with the available information, and educated assumptions, the promised compensation and the number of claimants in each category.

Table 6: Contingent Issues of Focus, Claims Agreed and Claimants Affected

	Amount Agreed	Number of Claimants
ECONOMIC		
Accommodation		
Land And Building Compensation	$15,000 per Household on average	25,000
Evacuation Cost / Moving Cost	$ 50 per family	25,000
House Lease Assistance/House Rental Contract	2-year of $ 500 per family,	25,000
Monthly Living Assistance	$ 30 per month per person for 9 months,	50,000
Provide Food (3 Times/Day) at Shelter Locations	$ 2 per person per day	50,000
Provide Amenities and Facilities at Shelter Locations	No Agreement	50,000
Agriculture and Farming (The provision of compensation to farmers for mud affected crop failure)		
Compensation for Failed Harvests - Rice Fields	$ 2,000 on average per failed harvest	1,000
Compensation for Failed Harvests - Farms	$200 on average per failed harvest	1,000
Compensation for Loss of Future Livelihood	Not Given	1,000
Business		
Temporarily Factory Relocations	$50,000 on average per factory relocated	10
Permanent Factory Relocations	$15,000 on average per factory relocated	10
Evacuation Support	$1,600 on average per Factory	
Small Business Compensation	$1,500 on average per Small Business	300
Salary Assistance for workers of Affected Factories	$70/ worker / month.	2,500
Compensation for Companies that have been Forced to Cease Operating	$600,000 on average per Ceased Business	12
ENVIROMENTAL		
Compensation to Villagers Due to Bad Smells, Dust, Noise, Etc	$30 per person	50,000
Provision of Clean Water to Affected Communities (Water Aid)	20 litres per person per day	50,000
Reduce Social Impacts Experienced by Residents in the Mudflow Prevention Activities	12 villages affected	12
Social Impacts Arising as a Consequence of Geological Deformations that Threaten the Safety of Residents	16 villages affected	16
Social Impacts arising as a Consequence of Geological Deformations that Cause Pollution of Soil and Irrigation Water	16 villages affected	16

SOCIAL		
Health		
Free Medical Services and Facilities	$5 on Average per Patient	70,861
Free Hospitalisation	$50 on Average per Patient	1,665
Burial Assistance	$ 100 /person	200
Cost of Life Assurance and Assistance to Affected Communities,	$30 per person for 9 months	37,151
Refugee Management	Not Disclosed	
Education		
School Educational and Transport Assistance	$ 5,000 spent in total	
Empowerment Programs (Skills Training)	Not Disclosed	
Other Social		
Better Deal with the Emotional Stresses	Not Disclosed	
Provide Information, Education and Counselling	Not Disclosed	
Managing Emotional and Spiritual Problems	Not Disclosed	
Source: Public Records and Interviews		

The principle focus of the paper was to provide a comparison between the disaster financing predictions made using economic calculations; and the incremental financing required using contingent valuation techniques, i.e. the amount of financing that will better alleviate the human suffering. For the disaster financing (economic) predictions, the researchers used secondary sources.

Brawijaya University published a comprehensive report on the predicted financing costs, using pure economic valuation methodologies, and these are presented in Table 8 (BPK – RI, 2007, Richards, 2011). In terms of the expenditure for *Land, Building & Infrastructure Costs*, the researchers used the same vales for their contingent value calculations, as the scope of the interviews did not cover these valuations.

However, the interviews were designed to obtain the contingent value of the *Cost of Business Interruption* such relocation and compensation costs and the replacing employees' wages of the inundated companies, and here considering that there were over 2500 workers involved initially. Here many assumptions had to be made. For example, it was assumed that the number of unemployed workers will whittle to a hard core of 500 by year 6 (as we uncovered) but that even those employed were not happy with their change of circumstance, and thus all workers will have a claim to be supported for 10 years in total.

Contingent value calculations were also done for the *Cost for Housing and Moving* which included House purchasing, leasing for a two year period and once-off moving costs.

This information was then used by the researchers as a starting point to pose CVM questions to the interviewees, as to what incremental finance would be needed to alleviate the economic, environmental and social costs of the mud disaster. From these interviews, averages were calculated for each contingent issue as to the incremental finance required, and the number of claimants outstanding.

The incremental financing calculations were limited to the period 2012-2015 (4-years) so as to compare with other economic calculations, and also place a finite date as to compensation (i.e. up to 10 years after disaster). All future cash flows were discounted at a 15% cost of capital. This is presented in Table 7, and shows that total incremental contingency financing costs of approximately $ 200 million would alleviate the economic, environmental and social costs suffered by those affected by the mud disaster.

Table 7: Contingent Issues of Focus and Incremental Financing Needs

Contingency Issue	Contingency Needs	Estimated Number of Claimants	Present Contingent Value
ECONOMIC			
Accommodation			
Land And Building Compensation	$15,000 per Household on average over 4 years	5,000	$ 61,560,471
Evacuation Cost / Moving Cost	$ 500 per family on average over 4 years	2,500	$ 1,026,008
House Lease Assistance/House Rental Contract	$ 500 per family per year for 4 more years	5,000	$ 8,208,063
Monthly Living Assistance	$ 50 per month per person for 4 more years	20,000	$ 39,398,701
Provide Food (3 Times/Day) at Shelter Locations	$ 2 per person per day for 4 more years	5,000	$ 11,983,772
Provide Amenities and Facilities at Shelter Locations	$ 1 per person per day for 4 more years	5,000	$ 5,991,886
Agriculture and Farming (The provision of compensation to farmers for mud affected crop failure)			
Compensation for Failed Harvests - Rice Fields	$ 2,000 on average per year per failed harvest for 4 more years	500	$ 3,283,225
Compensation for Failed Harvests - Farms	$ 1,000 on average per year per failed harvest for 4 more years	500	$ 1,641,613
Compensation for Other Loss of Future Livelihood	$ 1,000 on average per year for 4 more years	1,000	$ 3,283,225
Business			
Temporarily Factory Relocations	$50,000 averaged over 4 years per factory relocated	10	$ 410,403
Permanent Factory Relocations	$15,000 averaged over 4 years per factory relocated	10	$ 123,121
Evacuation Support	$1,600 averaged over 4 years per Factory	10	$ 13,133
Small Business Compensation	$1,500 on average per Small Business for 4-more years	500	$ 2,462,419
Salary Assistance for workers of Affected Factories	$70/ worker / month for 4-more years	2,500	$ 6,894,773
Compensation for Companies that have been Forced to Cease Operating	$600,000 averaged over 4 years per Ceased Business	12	$ 5,909,805
ENVIROMENTAL			
Compensation to Villagers Due to Bad Smells, Dust, Noise, Etc	$100 per person per year for 4-more years	30,000	$ 9,849,675
Provision of Clean Water to Affected Communities (Water Aid)	$1 per day per person for 4-more years	30,000	$ 35,951,315
Reduce Social Impacts Experienced by Residents in the Mudflow Prevention Activities	$3,000 per village averaged over 4-years	12	$ 29,549

Social Impacts Arising as a Consequence of Geological Deformations that Threaten the Safety of Residents	$5,000 per village averaged over 4-years	16	$ 65,665
Social Impacts arising as a Consequence of Geological Deformations that Cause Pollution of Soil and Irrigation Water	$5,000 per village averaged over 4-years	16	$ 65,665
SOCIAL			
Health			
Free Medical Services and Facilities	$10 on Average per Patient per year for 4-more years	70,000	$ 2,298,258
Free Hospitalisation	$50 on Average per Patient per year for 4-more years	2,000	$ 328,323
Burial Assistance	$ 100 per person averaged over 4 years	100	$ 8,208
Cost of Life Assurance and Assistance to Affected Communities,	$30 per person per year for 4-more years	35,000	$ 3,447,386
Refugee Management	$100 per person per year for 4-more years	20000	$ 6,566,450
Education			
School Educational and Transport Assistance	$ 50,000 per year for 4-more years	1	$ 328,323
Empowerment Programs (Skills Training)	$10,000 per year for 4-more years	1	$ 164,161
Other Social			
Better Deal with the Emotional Stresses	$5,000 per year for 4-more years	1	$ 65,665
Provide Information, Education and Counselling	$2,000 per year for 4-more years	1	$ 32,832
Total Incremental Contingency Financing Costs			**$ 211,392,091**

The present contingent values of the incremental financing required (Table 7) was then incorporated into the economic financing costs already estimated by the Brawijaya University report on economy impacts assessment of the mud flow in 2006; in order to predict the financial cost s for replacement based on both the economic and contingency components. This is presented in Table 8.

In the case of ***Environmental Costs*** of handling the mud, and the social disruption costs that were a consequence, the researchers used the same vales for the stopping the eruption and surface management costs, as the scope of the interviews did not cover these valuations. However, it did cover the environmental social impacts caused by the disruption to the fabric of the society caused by the disaster and its aftermath. Finally, in terms of ***Social Costs***, the interviews were designed to obtain the contingent values of (1) the cost of social welfare such as free health and education; (2) the management of emotional and spiritual problems; (3) information, education and counselling; and (4) empowerment and re-skilling costs. These are presented in Table 8.

Table 8: Prediction of the Financial Cost for Replacement Based on the Economic and Contingency Components 2006-2015 (US$)

No	Cost Component	The Prediction Value (US$)	
		Economic Values	***Contingent Values***
1	***Land, Building & Infrastructure Costs***		
	1.Land Destroyed	127,091,000	127,091,000
	2.Buildings Destroyed	108,012,000	108,012,000
	3.Replacing Productive Land	47,711,000	47,711,000
	4.Infrastructure Breakdown Costs	9,140,000	9,140,000
	Sub Total	*291,954,000*	*291,954,000*
2	***The Cost of Agriculture/ Business Interruption***		
	1.Relocation/ Compensation Costs	30,865,000	166,921,849
	2.Replacing employees wages	901,000	7,795,773
	Sub Total	*31,766,000*	174,717,622
3	***The Cost for Housing and Moving***		
	1. House Purchase/ Lease	1,665,000	9,873,063
	2. Moving Costs	174,000	7,779,591
	Sub Total	*1,839,000*	*17,652,654*
4	***Environmental Costs (Handling the Mud)***		
	1. To Stop the Eruption	84,175,000	84,175,000
	2. Surface Management	99,675,000	99,675,000
	3. Environmental Social Impacts	1,272,000	47,233,868
	Sub Total	*185,122,000*	*231,083,868*
5	***Social Costs***		
	The Cost of Social Welfare (Health/ Education/Insurance)	5,611,000	12,013,289
	Managing Emotional and Spiritual Problems	0	65,665
	Information, Education and Counselling	0	32,832
	Empowerment and Re-Skilling	0	164,161
	Sub Total	*5,611,000*	*12,275,947*
	TOTAL	**$516,292,000**	**$727,684,091**

Source (Economic Financing Costs): Brawijaya University Report on Economy Impacts Assessment of the Mud Flow 2006

Source (Contingent Financing Costs): Interviews with Stakeholders 2010-2013

Table 9: Prediction of Economic and Financial Costs to Lapindo and the Surrounding Regions in the period of 2006 – 2015

Economic Costs	Economic Costs*	Contingency Costs**
Direct Economic Cost (Table 3)	2,093,722,000	2,093,722,000
Indirect Economic Cost (Table 4)	748,618,510	748,618,510
Economic Cost for Recovering (Table 5)	589,386,000	589,386,000
Total Economic Cost	**3,431,726,510**	**3,431,726,510**
Financial Cost (Table 8)	516,292,000	727,684,091
Total Economic and Financing Costs	**3,948,018,510.00**	**4,159,410,601**
Gap (Economic Cost vs. Financial Cost)		**211,392,091**

Note:

1. Economic Cost: The value of the negative effect to the assets and people's income
2. Financial Cost (Economic): The value of cash that has been paid plus commitments
3 Financial Cost (Contingent): The value of cash that should have been paid based on interviews.

Source: Brawijaya University Report on Economy Impacts Assessment of the Mud Flow 2006

It should be noted that if the extra $200 million compensation is provided, the estimates of the difference between contingent costs and financial costs to Lapindo totalled to US$ 2.7 Billion. The gap may have to be borne by the people in and around Lapindo Regency. This gap has certainly decreased their quality of life and slowed the development of the Regency.

Summary

This paper examines the impact of the Lapindo (Lapindo or Lapindo) mudflow disaster in East Java province, and considers its long-term impact to the economy, the environment and the society in the surrounding region. This paper values the total cost of this unprecedented human disaster using a mixed-valuation method, termed 'Contingent Loss Assessment', which integrates the economic loss assessment of the disaster with a contingent valuation of the environmental and social costs.

It study was completed in 2014, over 8 after the occurrence date, and avoids a characteristic common to all natural disasters in that damage estimates calculated shortly afterward tend to be significantly overstated. The reasons given for such an overestimation is that it gets more media attention and increases political leverage over federal disaster assistance monies. The fact that Lapindo had no direct human lives lost also could result is an overestimation of monetary losses. However, eight years after the event, these media and politically driven estimation are replaced by harsh realities of consequential human suffering.

Disaster losses manifest themselves in numerous ways and, unfortunately, can never be estimated with absolute certainty. In this paper, for economic assets (e.g. physical asset s) the valuations were obtained from secondary sources (BPK – RI, 2007, Richards, 2011) in which discounted values were used, where period zero was the disaster year of 2006, with a ten year life to 2015. Given that 6 years have already passed, and the mudflow is expected to continue (by some estimates) for up to 30 years or more, perhaps a 10-year life is too short. Economic values were, however, not the primary focus of the paper. The focus of the paper instead was to provide a comparison between the disaster financing predictions provided using economic calculations and the amount of financing that will better alleviate the human suffering, valued in monetary terms, using contingent valuation techniques.

Calculating the economic costs involved estimating the aggregate impacts on economic variables like gross domestic product (GDP), consumption and inflation due to the effects of disasters, as well as the estimation of the

reallocation of government resources for relief and reconstruction efforts. The economists quoted in the paper have attempted to measure the economic cost of the disaster by estimating two separate types of losses: direct and indirect. The *Direct losses* calculated consisted of the crops, buildings or structures that were destroyed or damaged as a result of the mudflow (Table 3). Indirect secondary losses were the consequences of the direct losses. These included the cost of lost output, retail sales, wages and work time, additional time transporting goods or commuting to work (reduced leisure), additional costs to business from rerouting goods and services around the affected area, utility disruptions, reduced taxable receipts, lost tourism and increased financial market volatility (Table 4). In addition to the direct and indirect costs, to assess the full *macroeconomic* impact of the disaster, an estimation of the relief and restoration effort to 'recover' the land, business and infrastructure needs to be done. These effects cannot simply be added to the direct and indirect effects without causing duplication, as they are partially accounted for by those already. As such, only the incremental economic costs to 'recover' the land, business and infrastructure are presented in Table 5.

In addition to the economics costs, the environmental and social consequences also have economic repercussions, since loss of business and livelihoods can affect human health and well-being. In terms of the social consequences relating to environmental issues, there are social impacts experienced by residents who are displaced by mudflow prevention activities, and as a consequence of geological deformations that threaten the safety of residents. Social impacts also arise as a consequence of geological deformations that cause pollution of soil and irrigation water. In terms of societal impacts, in addition to health and education issues, affected people need to be counselled to better deal with the emotional stresses caused by the disruption to their family and their social fabric. Communication is important in terms of disseminating information, re-skilling and counselling in managing emotional and spiritual problems. The economic predictions of the financing agreed to meet these costs are presented in Table 8, column 1.This paper used the contingent valuation method (CVM) to provide an alternative financing model, and this is presented in Table 8, column 2. A comparison of the two columns show that the predicted *economic financing costs* of the disaster falls far short of the predicted *CVM financing* costs needed to alleviate the human suffering that is still present eight years after the disaster. It is argued that this difference, an extra $200 million flowing directly to those affected, is not an amount that is beyond the scope of those who have undertaken the responsibility of providing compensation to those affected.

Note that as the CVM involves directly asking people, in a survey, how much they would be willing to pay/accept to alleviate a specific environmental or social issue. It is called "contingent" valuation, because people are asked to state their willingness to pay/accept, contingent on a description of a specific environmental or social service. The fact that the contingent valuation method is based on asking people questions, as opposed to observing their actual behaviour, is the source of enormous controversy. Many economists, psychologists and sociologists, for many different reasons, do not believe the dollar estimates that result from CV are valid. This remains a limitation of this paper, and the results should be interpreted with caution.

Table 9 also shows that *economic financing costs* and the *contingent financing costs* of the disaster falls far short of the actual economic costs of the disaster by 2.9 and 2.7 Billion dollars respectively. This is the gap that is being borne by the people in and around Lapindo Regency whose quality of life has decreased at a micro-level, and slowed the development of the Regency at the macro-level.

References

ADB (2002) *Handbook for Integrating Risk Analysis in the Economic Analysis of Projects*, Economics and Research Department (ERD), Asian Development Bank, Manila, Philippines

Ananda, C. (2007) Development and Environment in East Java Province, in *Empowering Regional Economic Development toward Sustainable Poverty Alleviation*,

Ananda, C.F. Resosudarmo, B.P. and Nazara, S. (Editors), Indonesian Regional Science Association, Jakarta, Indonesia.

BPK - RI *(2007), Auditing the Hot Mud Eruption In Lapindo, East Java, Indonesia with Environmental Perspectives* A paper prepared for the Eleventh Meeting of INTOSAI-WGEA, June 28, Arusha, Tanzania.

Brookshire, D. and McKee, M. (1992*). Other Indirect Costs and Losses from Earthquakes*. Final report by Development Technologies to the Federal Emergency Management Agency (FEMA): Indirect Economic Consequences of a Catastrophic Earthquake (Track A Scoping Study), Washington, DC, USA.

Friends of the Earth International (2007) Lapindo Brantas and the Mud Volcano, Lapindo, Indonesia, June, *Background paper*, http://www.foeeurope.org/publications/2007/LB_mud_volcano_Indonesia.pdf (Accessed 8 March 2011)

McMichael, H. (2009)*'The Lapindo mudflow disaster: environmental, infrastructure and economic impact'*, Bulletin of Indonesian Economic Studies, 45:1, 73- 83

Plumlee, G.S., Casadevall, T.J., Wibowo, H.T., Rosenbauer, R.J., Johnson, C.A., Breit, G.N., Lowers, H.A., Wolf, R.E., Hageman, P.L., Goldstein, H., Anthony, M.W., Berry, C.J., Fey, D.L., Meeker, G.P. and Morman, S.A. (2008) *Preliminary Analytical Results for a Mud Sample Collected from the LAPINDO Mud Volcano, Lapindo, East Java, Indonesia*, US Geological Survey Open-File Report 2008-1019, USGS, Reston VA, USA.

Richards, J.R. (2011), *Report into the Past, Present and Future Social Impacts of Lumpur Lapindo*, Humanitus Lapindo Fund, Humanitus Foundation, Australia.

Rumiati, T. (2007) Analisa resiko terhadap hasil prediksi aspek teknis 5 tahun [Risk analysis of technical aspects of 5-year prediction results], in *Analisis Resiko Bencana Lumpur Porong, Skala Lokal Lapindo dan Skala Regional Jawa Timur* [*Porong Mud Disaster Risk Analysis, Lapindo Local and East Java Regional Scale]*, Report published by the Department of the Environment and the Surabaya Institute of Technology, August, Surabaya, Indonesia.

Santosa, B.H and McMichael, H. (2004), Industrial development in East Java: A special case?, *Working Papers in Trade and Development No. 2004-07*, College of Asia and the Pacific, Australian National University, November, Canberra, Australia.

Setiadi, R. (2007) Memantau Daerah Menyemai Kemajuan: Otonomi Daerah Dan Otonomi Award Di Jawa Timur [Observing the Regions Propagating Progress: Regional Autonomy and the East Java Autonomy Awards], *Jawa Pos Institute of Pro Otonomi*, January, Surabaya, Indonesia.

Timson, L. and Ker, P. (2015) Now the river is dead - BHP's mud disaster Sunday explainer, *Sydney Morning Herald*, http://www.smh.com.au/world/sunday-explainer-now-the-river-is-dead--bhps-mud-disaster-20151127-gla1l0.html (Accessed Dec 8 2015)

UNEP (2008) *Evaluation of Mud Flood Disaster Alternatives in Lapindo Regency, Draft Final Report*, United Nations Environment Programme, June, Jakarta, Indonesia.

World Bank and Asia Foundation (2005) *Improving the Business Environment in East Java: Views from the Private Sector*, The World Bank and The Asia Foundation, Jakarta, Indonesia.

Yahya, K. (2007) *Tantangan Penyelesaian dan Penanggulangan Lumpur Porong [The Challenge of Solving and Overcoming the Porong Mud Problem]*, PowerPoint presentation for briefing to Lapindo Mudflow Handling Agency, February, Jakarta, Indonesia.

Appendix 1

A Comparison of Valuation Methods		
Dollar-based Valuation Methods	**Advantages**	**Limitations**
Market Price Method	The market price method reflects an individual's willingness to pay for costs and benefits of goods that are bought and sold in markets, such as fish, timber, or fuel wood. Thus, people's values are likely to be well-defined. ŸPrice, quantity and cost data are relatively easy to obtain for established markets. The method uses standard, accepted economic techniques.	1. Market data may only be available for a limited number of goods and services provided by an ecological resource and may not reflect the value of all productive uses of a resource. 2. The method cannot be easily used to measure the value of larger scale changes that are likely to affect the supply of or demand for a good or service. 3.Usually, the market price method does not deduct the market value of other resources used to bring ecosystem products to market, and thus may overstate benefits.
Productivity Method	1. In general, the methodology is straightforward. 2. Data requirements are limited, and the relevant data may be readily available, so the method can be relatively inexpensive to apply.	1. The method is limited to valuing those resources that can be used as inputs in production of marketed goods. 2. When valuing an ecosystem, not all services will be related to the production of marketed goods. Thus, the inferred value of that ecosystem may understate its true value to society. 3. Information is needed on the scientific relationships between actions to improve quality or quantity of the resource and the actual outcomes of those actions. In some cases, these relationships may not be well known or understood. 4. If the changes in the natural resource affect the market price of the final good, or the prices of any other production inputs, the method becomes much more complicated and difficult to apply.

Hedonic Pricing Method	1. The method's main strength is that it can be used to estimate values based on actual choices. 2. Property markets are relatively efficient in responding to information, so can be good indications of value. 3. Property records are typically very reliable. 4. Data on property sales and characteristics are readily available through many sources, and can be related to other secondary data sources to obtain descriptive variables for the analysis. 5. The method is versatile, and can be adapted to consider several possible interactions between market goods and environmental quality.	1. The scope of environmental benefits that can be measured is limited to things that are related to housing prices. 2. The method will only capture people's willingness to pay for perceived differences in environmental attributes, and their direct consequences. 3. Thus, if people aren't aware of the linkages between the environmental attribute and benefits to them or their property, the value will not be reflected in home prices. 4. The method assumes that people have the opportunity to select the combination of features they prefer, given their income. However, the housing market may be affected by outside influences, like taxes, interest rates, or other factors. 5. The results depend heavily on model specification. Large amounts of data must be gathered and manipulated. 6. The time and expense to carry out an application depends on the availability and accessibility of data.
Travel Cost Method	1. The travel cost method closely mimics the more conventional empirical techniques used by economists to estimate economic values based on market prices. 2.The method is based on actual behaviour—what people actually do—rather than stated willingness to pay—what people say they would do in a hypothetical situation. 3. The method is relatively inexpensive to apply. 4. On-site surveys provide opportunities for large sample sizes, as visitors tend to be interested in participating. 5.The results are relatively easy to interpret and explain.	1. The travel cost method assumes that people perceive and respond to changes in travel costs the same way that they would respond to changes in admission price. 2. The availability of substitute sites will affect values. 3. Defining and measuring the opportunity cost of time, or the value of time spent traveling, can be problematic. 4. The travel cost method is limited in its scope of application because it requires user participation. 5. As in all statistical methods, certain statistical problems can affect the results.

Damage Cost Avoided, Replacement Cost, and Substitute Cost Methods	1. The methods may provide a rough indicator of economic value, subject to data constraints and the degree of similarity or substitutability between related goods. 2. It is easier to measure the costs of producing benefits than the benefits themselves, when goods, services, and benefits are non-marketed. Thus, these approaches are less data- and resource-intensive. 3. Data or resource limitations may rule out valuation methods that estimate willingness to pay.	1. The replacement cost method requires information on the degree of substitution between the market good and the natural resource. Few environmental resources have such direct or indirect substitutes. 2. The methods may be inconsistent because few environmental actions and regulations are based solely on benefit-cost comparisons, particularly at the national level. Therefore, the cost of a protective action may actually exceed the benefits to society.
Contingent Valuation Method	1. Contingent valuation is enormously flexible in that it can be used to estimate the economic value of virtually anything. 2. CVM is the most widely accepted method for estimating total economic value, including all types of non-use, or "passive use," values. CVM can estimate use values, as well as existence values, option values, and bequest values. 3. Though the technique requires competent survey analysts to achieve defensible estimates, the nature of CVM studies and the results of CVM studies are not difficult to analyse and describe. Dollar values can be presented in terms of a mean or median value per capita or per household, or as an aggregate value for the affected population. 4. CVM has been widely used, and a great deal of research is being conducted to improve the methodology, make results more valid and reliable, and better understand its strengths and limitations.	1. Considerable controversy over whether it adequately measures people's willingness to pay for environmental quality. 2. The expressed answers to a willingness to pay question in a CVM format may be biased because the respondent is actually answering a different question than the surveyor had intended. 3. Respondents may make associations among environmental goods that the researcher had not intended. 4. Some researchers argue that there is a fundamental difference in the way that people make hypothetical decisions relative to the way they make actual decisions. 5. The valuations have an "embedding effect." 6. Strategic bias arises when the respondent provides a biased answer in order to influence a particular outcome. 7. Estimates of non-use values are difficult to validate externally. 8. When conducted to the exacting standards of the profession, contingent valuation methods can be very expensive and time-consuming, because of the extensive pre-testing and survey work.

Contingent Choice Method	1. The contingent choice method can be used to value the outcomes of an action as a whole, as well as the various attributes or effects of the action. 2. The method allows respondents to think in terms of tradeoffs, which may be easier than directly expressing dollar values. 3. The method minimizes many of the biases that can arise in open-ended CVM studies where respondents are presented with the unfamiliar and often unrealistic task of putting prices on non-market amenities.	1. Respondents may find some tradeoffs difficult to evaluate, because they are unfamiliar. 2. When presented with a large number of tradeoff questions, respondents may lose interest or become frustrated. 3. Contingent choice may extract preferences in the form of attitudes instead of behaviour intentions. 4. By only providing a limited number of options, it may force respondents to make choices that they would not voluntarily make. 5. Translating the answers into dollar values, may lead to greater uncertainty in the actual value that is placed on the good or service of interest.
Benefit Transfer Method	1. Economic benefits can be estimated more quickly than when undertaking an original valuation study. 2. The method can be used as a screening technique to determine if a more detailed, original valuation study should be conducted. 3. The method can easily and quickly be applied for making gross estimates of recreational values. The more similar the sites and the recreational experiences, the fewer biases will result.	1. Benefit transfer may not be accurate, except for making gross estimates of recreational values, unless the sites share all of the site, location, and user specific characteristics. 2. It may be difficult to track down appropriate studies, since many are not published. 3. Adequacy of existing studies may be difficult to assess. 4. Benefit transfers can only be as accurate as the initial value estimate. 5. Extrapolation beyond the range of characteristics of the initial study is not recommended
source: http://www.ecosystemvaluation.org/uses.htm		