CATDAT

Integrated Historical Global Catastrophe Database

The Economics of Earthquakes since 1900

What is in an economic estimate?

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abstract

Problem Definition

With the increasing number of earthquake effect databases and reports worldwide, the number of erroneous and contradicting figures is increasing. Economic damage values are generally difficult to quantify and there exist a great range of values for any one earthquake. In addition, the tools to make a valid economic comparison of earthquake losses through time are lacking.

What is the CATDAT Economic Section?

The newly-formed CATDAT damaging earthquakes database contains economic damage and historic impact data on over 7000 earthquakes worldwide since 1900.

A damaging earthquake is entered into the CATDAT database by the following economic criteria:-
• Any earthquake causing damage or flow-on effects exceeding $100,000 international dollars, Hybrid Natural Disaster Economic Conversion Index adjusted to 2010.
• Any earthquake causing disruption with a reasonable economic or social impact as deemed appropriate.

This paper details the economic trends in earthquakes since 1900, with many economic loss values not reported in existing databases. An upper bound and lower bound range of economic loss estimates for each earthquake through history is contained within the database, including a median estimate. There is a significantly increased number of exact economic loss estimates found from various sources in foreign literature sources. Also created was an extensive global database of exchange rate information in order to be able to adjust foreign loss estimates. Global databases of CPI, wage rate, GDP (nominal and real) and other parameters such as PPP were also created.

Detailed economic analysis done as part of this study shows that the adjustment utilised by historical databases using simple inflation via Consumer Price Index greatly underestimates the impact of historic earthquakes, giving less significance to historic events. Thus, a hybrid index is shown to better account for the historical cost of earthquakes in today's terms, using a combination of wages, construction costs, workers' production, GDP, CPI and other tools.

How does this help the community?

CATDAT provides a significantly increased database of standardised historic economic earthquake loss information combined with economic analysis not before undertaken for global earthquakes. These tools and indices provide a basis to bring any historic loss value into a present day value. It is also the first step towards normalising losses with changing infrastructure.

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What is contained in an economic loss estimate?

Some of the many components contributing to economic gains and losses from earthquakes are shown below.

Loss Type	Direct		Indirect	Aid
Tangible	Property (Private with residential and non-residential, Public infrastructure). Other built infrastructure.		Business Disruption, inter-industry effects, Loss of Public Services. Household alternative accommodation Agriculture Transport disruption Relief and Response costs Residential and Non-Residential cleanup wages and materials/ demand surge. Postponed impacts – household spending.	Aid payments Rebuilding Assistance Survivor benefits Unemployment compensation Bottleneck losses outside area. Network changes.
Intangible	Fatalities, injuries, homelessness, health effects (debilitation)		Lost tourism – Environmental, cultural and historic assets. Inconvenience.	Productivity of workers Ethics

Discrepancies in Economic Loss Estimates

Shown are the economic loss estimates from various sources for the 1923 Great Kanto earthquake.

Reference	Cost	Year of Cost	Cost in 1923 USD
CATDAT	$3840m	1923	$3840m (2800-4586)
EM-DAT	$600m	1923	$600m
NGDC	$600m	1923	$600m
MRNATHAN	$2800m ($30129m)	1923 (2003)	$2800m ($30129m US-CPI)
BSSA - Davidson	$4586m	1923	$4586m
Baron Inouye, Finance Minister	7000m-10000m ¥	1923	$3238m-$4625m
Chugai Commerce News	1494m ¥ (Insured cost)	1923	$691m (Insured)
Contemporary Newspapers	2200m ¥ (Insured cost)	1923	$1018m (Insured)

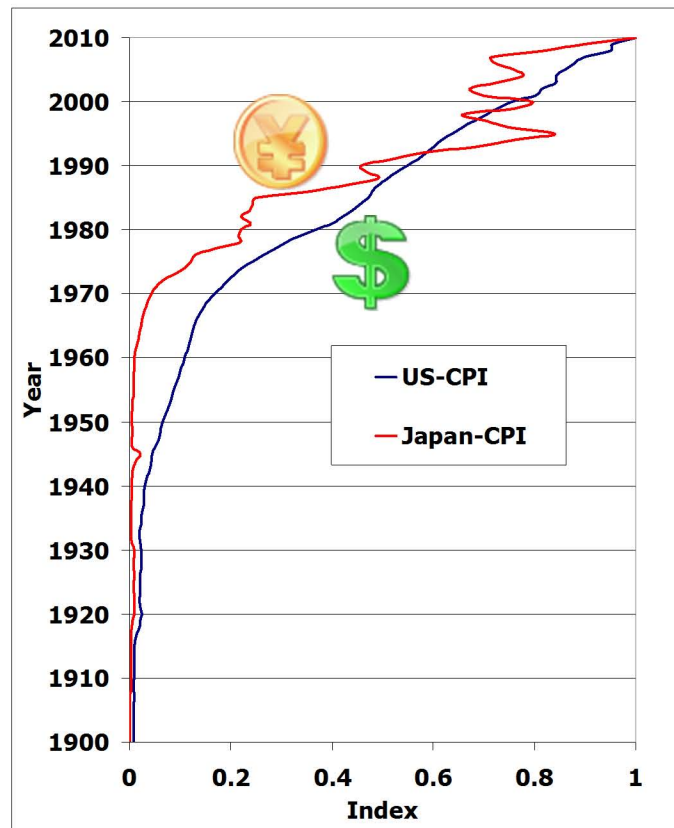### Why is CPI-adjustment not always correct?

Most existing databases use United States CPI for economic loss conversion. However, this does not account for a change in the development of a country against the USA.

The difference of CPI adjustment using US or Japanese trended data

1964 Niigata Earthquake	Original CPI 1964 Index	Cost in July 2010 USD	Adjustment Method
USD	0.1398	$5722m	USD CPI
Japanese Yen	0.0546	$14652m	Japanese CPI

Adjustment to 2010 dollars for two Japanese earthquakes

Adjustment Type	Niigata 1964 ($800m event)	Great Kanto 1923 ($3840m event)
Consumer Price Index	$14652m	$52531m
GDP Deflator	$12529m	
Unskilled Wage	$37320m	$203489m (0.0188)
GDP per capita	$44243m	$247686m
GDP	$51601m	$2783518m

Converting a historic EQ loss in today's terms

There are many ways to bring historic earthquake damage loss estimates forward to current-day dollars. The following list shows inflation adjustment measures for economic costs commonly used worldwide.
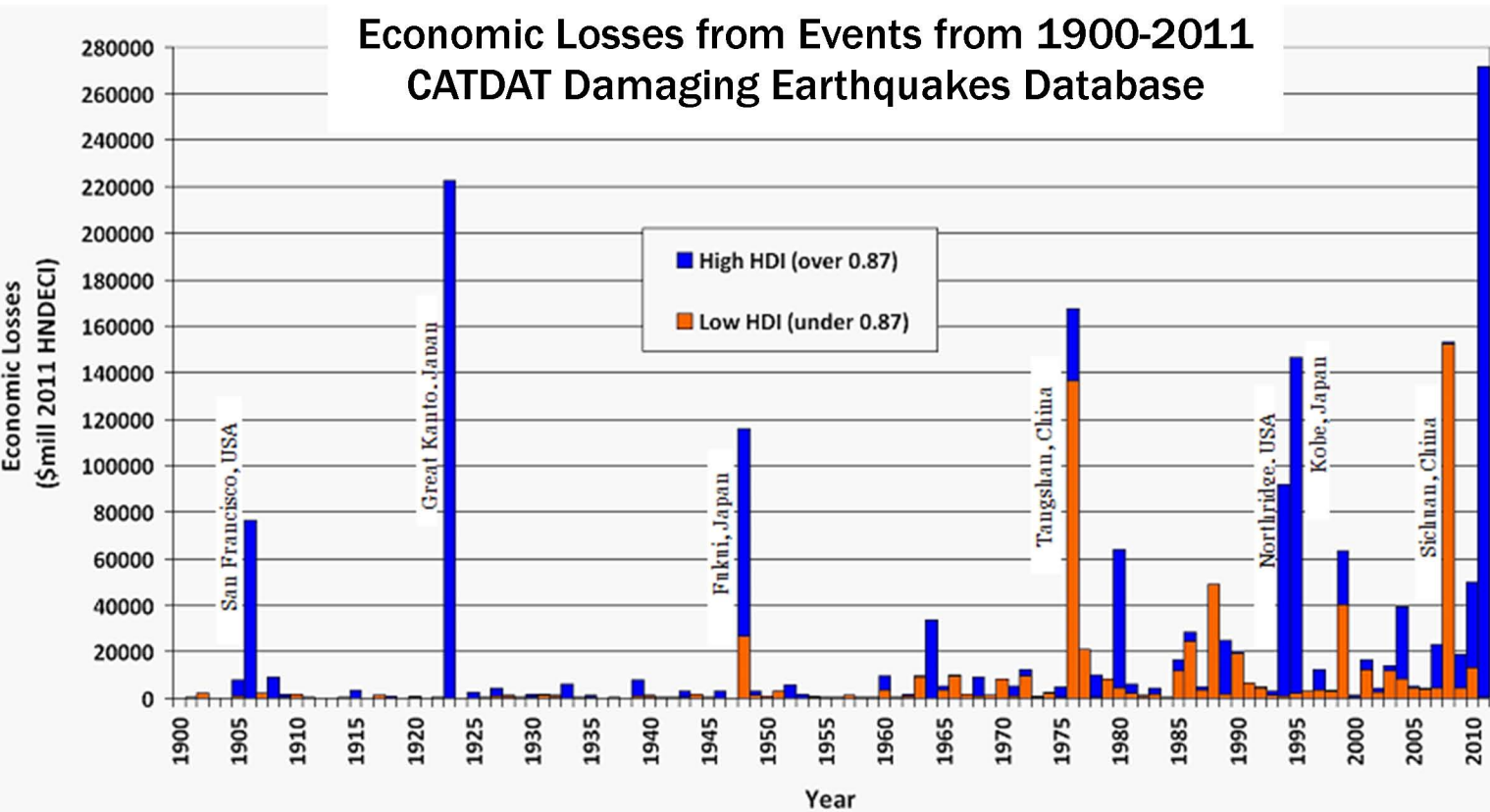
1. CPI (Consumer Price Index)
2. GDP Deflator
3. The Consumer Bundle
4. The Unskilled Wage
5. The Worker's Production Index
6. The Average Wage
7. Project Escalation Indices
8. The GDP per capita
9. Gross Domestic Product

Global Economic Losses 1900-2011: a new perspective

The Hybrid Natural Disaster Economic Conversion Index (HNDECI)

Natural Disaster Parameter	Adjustment to future terms	Reason
Property Loss	Country-based unskilled wage index	Historical trends have been matched to property loss with good correlation
Reconstruction Cost of Residential Buildings	Country-based EQLIPSE Building Inventory analysis	Building cost analysis gives closest value.
Crops, pastures, livestock	Using historical databases – if not, CPI.	CPI is most likely closest to the cost of crops and livestock.
Life Insurance and Intangible costs (Deaths, Injuries, Disability)	Proxy on premiums. Country-based average wage.	BTE (2001) trended most of this cost to above an unskilled wage
Indirect Losses via business interruption	Consumer Price Index	Economic values should be CPI adjusted (or interest rate)
Clean-up	A combination of material costs (CPI) and demand surge wage.	A 50-50 combination of CPI and unskilled wage.
Utilities and Transport Damage	Unskilled wage index.	Tied closer to construction materials and labour.

The greatest economic losses as a proportion of GDP

	Earthquake	Date	Event cost $US μ	% of Nominal GDP (PPP)	% of Nominal GDP
1	Spitak, Armenia	1988	16.20 bn	92.3*	358.9*
2	Port-au-Prince, Haiti	2010	7.754 bn	70.3	119.8
3	Guatemala	1976	3.900 bn	44.6	98.0
4	Managua, Nicaragua	1972	0.845 bn	19.7 to 38.3	67.1 to 96.2
5	Cartago, Costa Rica	1910	0.025 bn	63.5	≈90.0
6	Maldives Tsunami**	2004	0.603 bn	50.1	77.7
7	Concepcion, Chile	1906	0.260 bn	47.8	55 to 82.86
8	Wallis and Futuna	1993	0.014 bn	51.9	54.0
9	Great Kanto, Japan	1923	3.840 bn	29.8	52.8
10	Nicaragua	1931	0.030 bn	26.5	51.0
11	Jamaica	1907	0.013 bn	23.9	45.9
12	El Salvador	1986	1.500 bn	12.8	39.77
13	Chillan, Chile	1939	0.361 bn	21.5	31.75
14	Racha, Georgia*	1991	1.700 bn	3.5 to 17.0	17.2 to 85.0
15	Samoa**	2009	0.147 bn	17.8	26.34
16	El Salvador	1917	0.025 bn	15.8	≈26.0
17	Romania	1977	4.513 bn	8.54	17.23
18	Skopje, TFYR Macedonia*	1963	1.100 bn	9.00	16.50
19	Quito, Ecuador	1987	1.500 bn	7.21	16.48
=20	Fukui, Japan	1948	1.000 bn	3.59	15.56
=20	Chile	2010	30.00 bn	11.7	15.27

Economic Losses from Events from 1900-2011 CATDAT Damaging Earthquakes Database
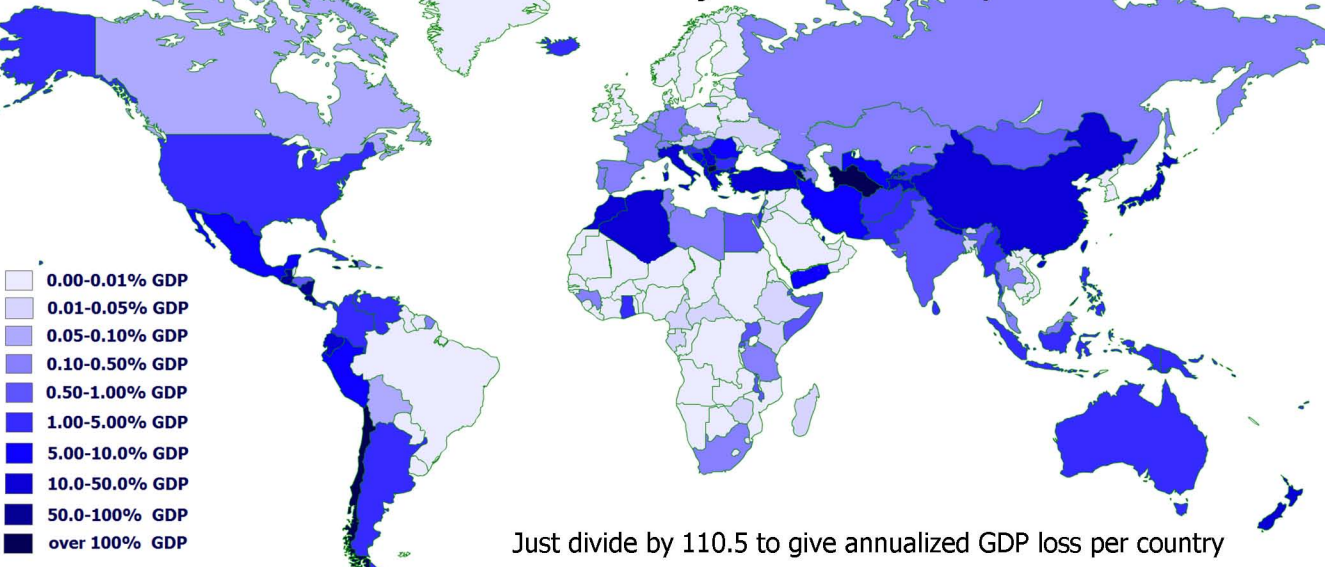
High HDI (over 0.87)
Low HDI (under 0.87)

The 2011 Sendai Earthquake has caused the largest economic loss of all time, and has finally changed the trend of economic losses to "increasing".

Cumulative Loss as a % of event year GDP (PPP) from 1900-2010

0.00-0.01% GDP
0.01-0.05% GDP
0.05-0.10% GDP
0.10-0.50% GDP
0.50-1.00% GDP
1.00-5.00% GDP
5.00-10.0% GDP
10.0-50.0% GDP
50.0-100% GDP
over 100% GDP

Just divide by 110.5 to give annualized GDP loss per country

HNDECI & Conclusion

Using the HNDECI allows for correct translation of historical economic losses into a 2011 $ without using a single adjustment parameter such as single country CPI.

Measuring worth indices to allow for conversion to current day dollars

The indices for a single country, Australia in this case, are shown below. It can be seen that the HNDECI for earthquakes in Australia is based primarily on the unskilled wage index. This is also because the construction cost index follows the unskilled wage very closely. This changes for each country.

Consumer Price Index
Unskilled Wage Index
HNDEC Index
Nominal GDP Index
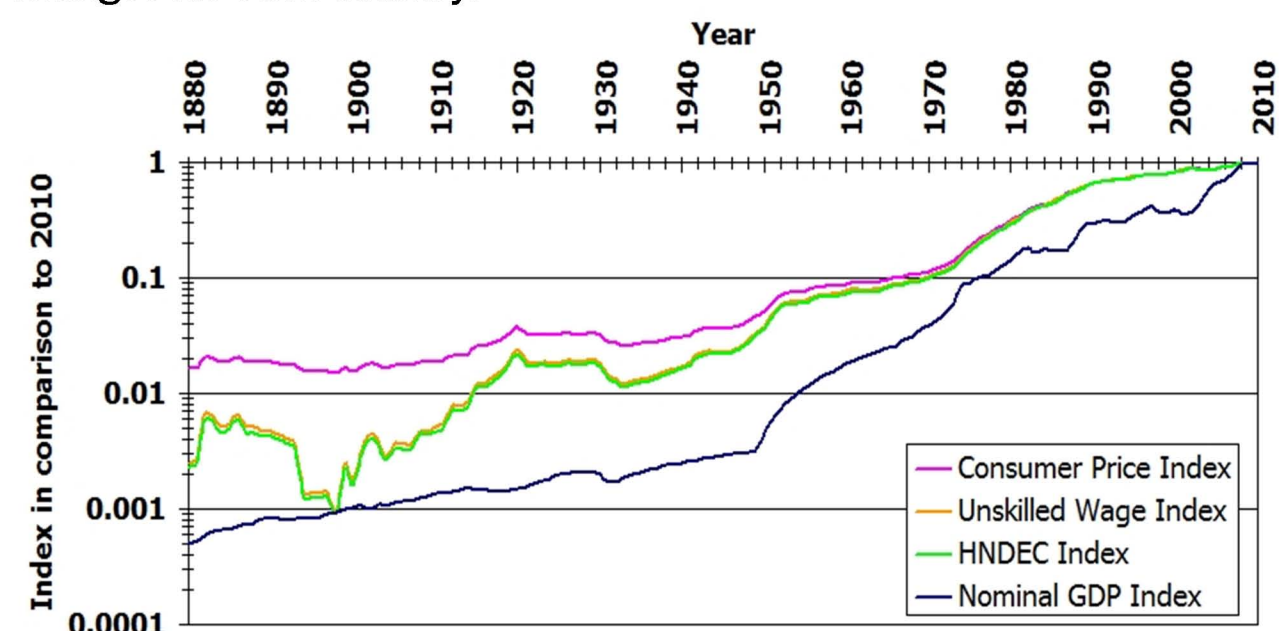
Conclusion

For each earthquake, the economic loss estimate provided from different sources is scrutinized and a range of values is entered into CATDAT. Using the socio-economic indices created from many sources, new insights into the cost of historic earthquakes today have been created and will continue to be found.

Cumulative Economic Losses
Cumulative Fatalities
Population ('000s)
World GDP (2010 International Dollars)
Linear (Cumulative Fatalities)