Sketch of a cost-benefit analysis of GGIS-DRR

Sean Brocklebank
University of Edinburgh
2014 - 05 - 01 — EGU Vienna

CBA of GGIS-DRR

- Is the Global Geohazards Information System for Disaster Risk Reduction (GGIS-DRR) a good idea?
  - We need to compare the costs & benefits
- What follows does not qualify as a proper cost-benefit analysis—it is just a sketch
  - A proper CBA would need more info
- I am going to focus on the extreme end of the geohazard spectrum, partly because I think that's where most of the action is (more on this later)

VEI 8s are mainly bad for food

"…a Toba-sized eruption in a similar location [today] would, besides killing tens of millions of people throughout Southeast Asia, destroy at least one or two seasons of crops needed to feed some 2 billion people in one of the world's most densely populated regions. This alone would be a catastrophe unprecedented in history, and it could be compounded by much reduced harvests around the world. Compared to these food-related impacts, the damage to machinery, or the necessity to suspend commercial flights until the concentrations of ash in the upper troposphere returned to tolerable levels, would be a minor consideration." (Smil, 2008)

The value of a statistical life

- Benefits
  - Main benefits will be from lives saved—ignore buildings, etc. for now
  - What's a life worth? There is a whole literature on this, but let's shortcut that and say that a credible number for the average human life is $2.22 million
    - (More detail in the White Paper)
  - And how many folk might die? I don't know, but every 1% of the global population is 70 million people, which is about $155 trillion if they die
    - World GDP is something like $70 to $85 trillion

How many deaths?

- So how many people would die in a Toba-sized event? I don't know.
  - 3% to 5% of the world population died in the 1918 flu pandemic, and a Toba redux feels like it would be worse
  - Let's call it 10% (we can shrink this number later if it seems too high—it doesn't matter much)

Willingness to pay for death avoidance

- If Toba II has a 1/100,000 of occurring each year, and the occurrence is associated with a 10% probability of death, then everyone faces a 1/1,000,000 chance of dying per year
- Given a VSL of $2.22 million, everyone should be willing to pay about $2.22 to eliminate the risk completely (which is impossible anyway)
  - That adds up to $15.5 billion / year ($2.22 / person x 7 billion people)

We can’t eliminate all Toba-related deaths

- Unlike asteroids, volcano monitoring can’t lead to total avoidance
- I think the benefits will mainly accrue if we can get some warning and take precautionary measures to protect the food supply and prevent starvation:
  - Given months’ warning, we could slaughter livestock, preserve feed and plan alternative transport networks
  - Given years’ warning, we can conduct agricultural experiments to help us determine which crops to grow where in a new climate
  - Other stuff…

Willingness-to-pay for fewer deaths

- The willingness-to-pay (WTP) of $15.5 billion / year from a few slides ago is only if the risk can be eliminated (i.e. we save 10% of the world population who otherwise would have died)
  - If we save 9% instead of 10%, WTP is $14 billion / year
  - If we save 5% instead of 10%, WTP is $7.75 billion / year
  - If we save 2% instead of 10%, WTP is $3.1 billion / year
- Let's say we can save 5%--then the annual WTP is about $8 billion

Costs

- How much would it cost to operate the GGIS-DRR? You probably know better than me. Here's how I guessed:
  - The USGS spends $24.7 million monitoring volcano hazards
  - The USA is about 1/15 of the land surface of the Earth
  - Cavalierly, I assume a cost of $370 million ($24.7 million x 15 USAs)

Cost-benefit ratio

- If we can reduce the deaths by 5% of world population with enough warning, then the WTP is $8 billion, which is more than 20 times larger than the guesstimated costs of $370 million
  - Cost-benefit ratio > 20
    - That's a lot

Other things I was cavalier about

- VSLs could be a lot higher, depending on the method
- Omitted the value of reducing the likelihood of large-scale war
- “Rounding errors”
  - Cost of physical destruction
  - Cost of implementing emergency measures
- Tail risk: infinite?

Tail risk

- Imagine a lottery ticket which gives you different probabilities of winning prizes of different sizes

The red and the black

Prize number	Probability of prize	**Red** ticket prizes (prizes rise by 5x)		**Black** ticket prizes (prizes rise by 20x)	
		Prize	EV	Prize	EV
1	0.1	$10	$1	$10	$1
2	0.01	$50	$0.50	$200	$2
3	0.001	$250	$0.25	$4 000	$4
4	0.0001	$1250	$0.125	$80 000	$8
etc…	…	…	…	…	…
		EV :	$2	EV :	Infinite

Things we need to know

- Every number I used was a bit rough-and-ready, but the two things we really need to know more about are:
  1. What would be the effect on the food supply?
     - & how many would die if we do nothing?
  2. How much would GGIS-DRR cost?

References

Rose, W. I., and C. A. Chesner. "Dispersal of ash in the great Toba eruption, 75 ka." *Geology* 15, no. 10 (1987): 913-917.

Robock, Alan, Caspar M. Ammann, Luke Oman, Drew Shindell, Samuel Levis, and Georgiy Stenchikov. "Did the Toba volcanic eruption of∼ 74 ka BP produce widespread glaciation?." *Journal of Geophysical Research: Atmospheres* (1984–2012) 114, no. D10 (2009).

Smil, Vaclav. *Global catastrophes and trends: the next fifty years*. The MIT Press, 2008.

Smil, Vaclav. Harvesting the biosphere: The human impact. *Population and Development Review* 37(4) (2011) : 613–636

Taubenberger, Jeffery K., and David M. Morens. "1918 Influenza: the mother of all pandemics." *Rev Biomed* 17 (2006): 69-79.

Trottenberg, Polly, and Robert S. Rivkin. “Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses.” Revised Departmental Guidance, 2013.

U.S. Geological Survey (USGS). Bureau Highlights, BH – 53. USGS, 2013.

Viscusi, W. Kip, and Joseph E. Aldy. "The value of a statistical life: a critical review of market estimates throughout the world." *Journal of risk and uncertainty* 27, no. 1 (2003): 5-76.

World Bank. Development Data Group, ed. *World Development Indicators 2013*. World Bank-free PDF, 2013.