GeoHazards International

A Nonprofit Working Toward Global Earthquake Safety

Preventing Another Haitian Crisis: Preparedness and Mitigation as Aid

Transcript of a talk given by Dr. Brian E. Tucker
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Introduction

I would like to thank the World Affairs Council of Northern California and the Pacific Council on International Policy for inviting me to speak to you tonight. It is a particular pleasure to see in the audience many friends and colleagues from the earth sciences and earthquake engineering communities, some of whom I've known for decades. Thank you for coming out tonight.

The Haitian earthquake brings into focus the founding principles of my organization, namely to reduce death and suffering due to earthquakes in the world's most vulnerable communities through preparedness and mitigation. Our vision is that communities around the world should be able to develop their economies, governments and cultures unimpeded by periodic setbacks from earthquakes. Haiti reminds me of the urgency of our work and thus I welcomed this opportunity to talk to you about what should be done next in Haiti and what we might do together in other vulnerable communities.

I want to open tonight by offering the take-home message of this talk:

The death and suffering that the world has witnessed in Haiti these past weeks did not have to happen. We know the science and engineering of how to mitigate the effects of earthquakes. But unless we begin, collectively, to demand that this life-saving knowledge be applied in vulnerable communities, we can expect to see natural disasters continue to harm innocent people—and on a much larger scale than we have just witnessed in Haiti. The way to prevent another Haitian crisis is to start offering preparedness and mitigation support to the world's most vulnerable communities as our best, life-giving aid. We need to use some new approaches to be successful.

That take-home message may sound challenging. It is. But I hope that I am communicating the good news at its heart: we have the tools and the skills that we need to prevent the suffering of more innocent people. This is wonderful, like announcing the existence of a new, effective vaccine. Once you have developed and tested that vaccine, and you know that it works, you want to inoculate as many people as possible. You won't be satisfied simply to ease people's suffering, after they fall ill. You know that you can prevent the illness, if you can reach people in time.

To give a local example of successful prevention, in the century since the 1906 San Francisco earthquake, California has steadily improved its science, engineering and public policies to such an extent that the lethality of our earthquakes has been greatly reduced. The 1989 Loma Prieta earthquake and the 1988 Armenian earthquake had approximately the same magnitude and shook approximately the same number of people, but at least 25,000 Armenians died, compared to only 63 Californians. We know well how to mitigate the effects of earthquakes.

Tonight I want to talk about risk and prevention. First I will talk about the recent trends of global earthquake risk and we'll see how the Haitian earthquake fits into that picture. Then I will make some recommendations for reconstruction Haiti. Finally, I will invite discussion about new approaches to earthquake risk management in other threatened communities.

Trends in Global Earthquake Risk

Global earthquake risk is growing, rapidly. This may be surprising in light of California's progress. And some of you may know of international efforts, such as the UN International Decade of Natural Disaster Reduction in the 1990's, and the continuation of that effort as the UN International Strategy for Disaster Reduction. Despite these efforts, however, cities in developing countries are becoming more vulnerable.

This plot [Fig. 1], given to me by Roger Bilham of the University of Colorado, shows the growth of the world's population (in the dashed line) for the last 500 years, superimposed upon the cumulative number of fatalities from earthquakes, world-wide. Earthquake fatalities are plotted for ALL earthquakes, for those earthquakes that killed 30,000 people or fewer, and for those earthquakes that killed 5000 people or fewer. You can see that the fatalities have steadily increased with the population.

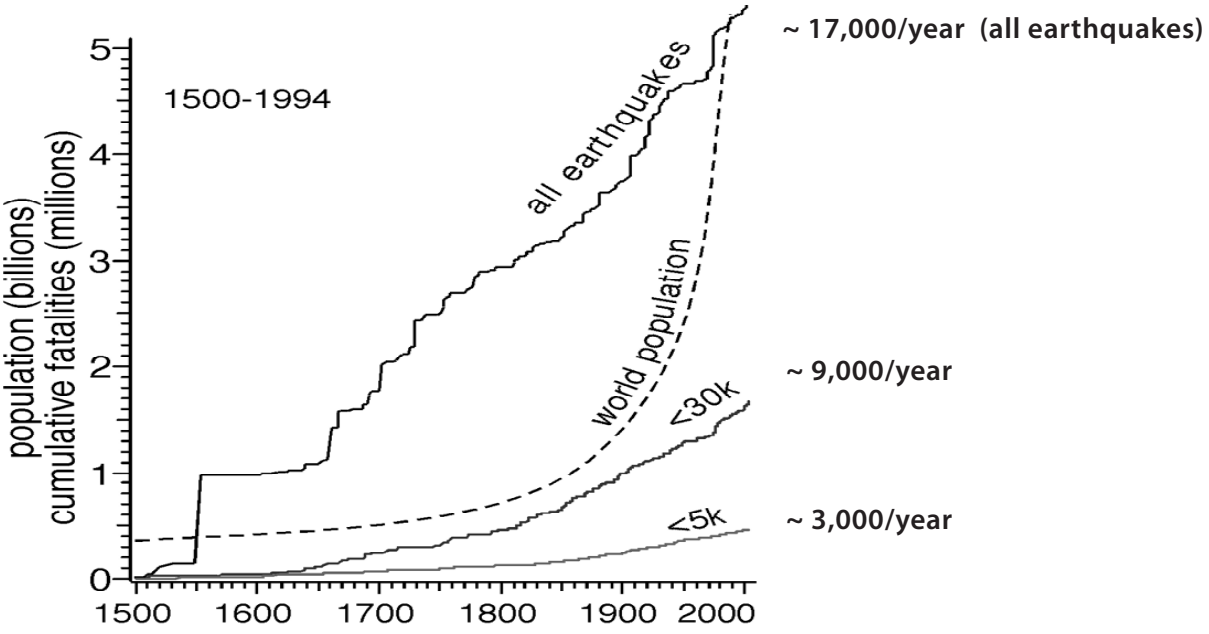

Figure 1. Statistical forecasts of future fatalities from past 500 years of earthquakes.

Bilham used these data to forecast the number of deaths that should have been expected in this first decade of the 21st century. The trend in the historical data indicates that we should have expected to see about 17,000 deaths per year due to all earthquakes. Yet Bilham found that the number of fatalities *actually* observed for all earthquakes in the last ten years was approximately twice that forecast. **These results suggest that earthquake risk is accelerating, actually increasing faster than population is, and that our risk reduction efforts have not yet had much effect.**

Bilham summarized the fatalities of all earthquakes in the 20th century in another plot [Fig. 2, following page]. Here the number of earthquakes in the last century is plotted as a function of fatalities per earthquake.

We see, for example, that, in the last century, there were several hundreds of earthquakes that killed about 10 people, and tens of earthquakes that killed about 10,000 people, and one earthquake that killed about 300,000. This was the 1976 Tangshan earthquake in China.

If we wanted to project what to expect in the 21st century, the first thing that we would need to do to this graph would be to factor in the increase in the world's population. The average population of the world in the 20th century was about 4 billion. In the 21st century, the global population average is expected to be, perhaps, 8 billion.

Of that population, it is estimated that over the next 25 years, approximately two billion people will be added to the population of cities in developing countries alone. This is particularly relevant, since a disproportionate number of those cities are earthquake-prone. Two billion people is equivalent to the current population of India and China, combined.

A second key factor in our projection would be the increase in the earthquake vulnerability of cities in developing countries. Rapid construction in poor economies makes for increasingly bad construction.

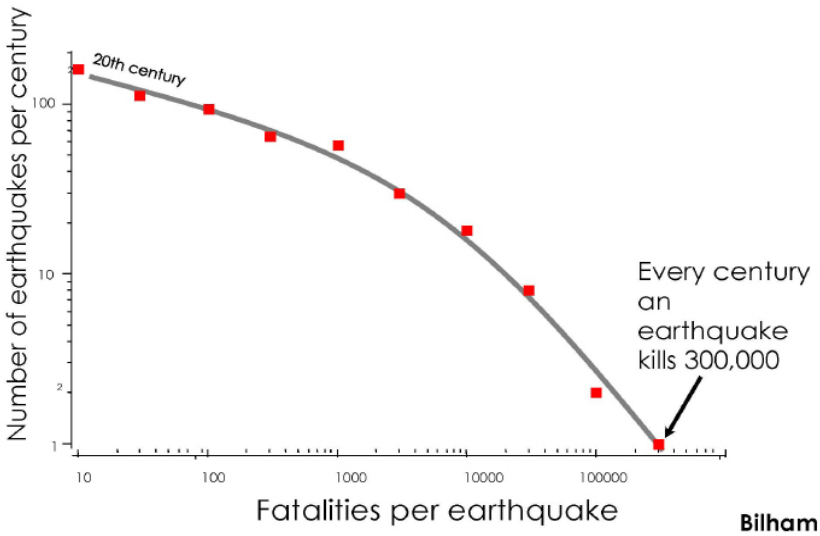

Figure 2. Fatalities from all 20th century earthquakes.

We at GeoHazards International have witnessed this increase in vulnerability in our work around the world. For example, I have seen safe, one-storey bamboo homes [Fig. 3] in the foothills of the Himalayas being replaced by poorly-constructed, non-engineered, multi-storey concrete- frame structures, frequently sited on steep slopes [Figures 4 and 5]. It doesn't take a structural engineer to recognize that these buildings will not perform well in an earthquake.

Figure 3. *Photo: B. Tucker*

These dual effects of increasing population and increasing vulnerability of cities in developing countries will push the curve in Figure 2 up and out….

Meanwhile, the graph in Figure 6 [following page] forecasts that in the 21st century, a single earthquake could result in 1 million fatalities.

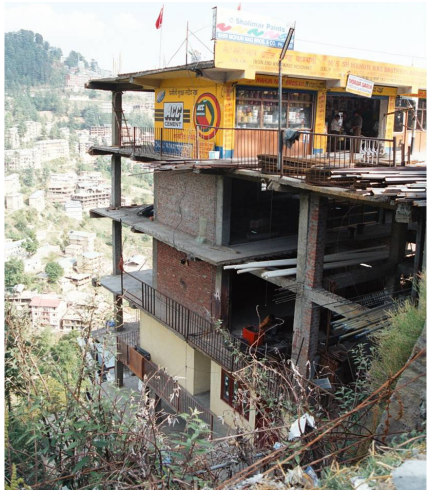

Figure 4. *Photo: B. Tucker*

Figure 5. *Photo: B. Tucker*

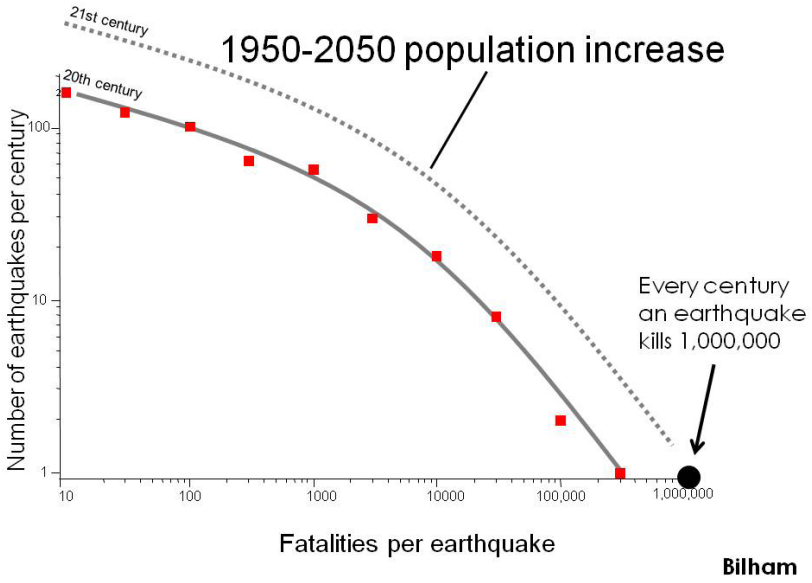

Figure 6. Forecast of fatalities per earthquake in the 21st century (R. Bilham)

The Haitian Earthquake

Now let's look at the earthquake faults and construction practices of Haiti. How does what happened in Haiti fit into our forecast of increasing vulnerability of buildings in developing countries?

Before the Haitian earthquake occurred, there had been eight earthquakes in recorded history that have killed 100,000 people or more. Six of these occurred since 1900, when we could measure their magnitude. Of those, the smallest event released six times more energy than the Haitian earthquake did, yet it killed fewer people. The typical earthquake event that killed 150,000 people—the estimate to-date of deaths in Haiti—released 20 times more energy than the Haitian earthquake released. These findings conform well to our expectations that earthquakes will become more and more lethal, as a result of declining earthquake-resistance of buildings.

Just as we know why poorly constructed buildings perform poorly in earthquakes, we know where earthquakes are likely to occur. This point is important, because after an earthquake or other natural disaster, we often hear people describe it as a bolt from the blue, something that no one could have anticipated. An "act of God."

This is incorrect and damaging speech. It damages the cause of earthquake safety when people think and are told that they can do nothing to protect their homes, schools and communities. We who know that they can do a lot to protect their communities have to keep spreading that message.

In Haiti, the death and suffering of so many innocent people as a result of the earthquake is absolutely tragic, in the sense that these people are not responsible for their suffering. But their suffering is not due to an unforeseeable "act of God." Earthquakes are not as frequent as hurricanes in the Caribbean, but they are common, and many large earthquakes had occurred in Haiti in the past.

You can see from this slide, provided to me by the USGS [Fig. 7, following page], that there have been scores of large earthquakes in Haiti over the past few centuries, some near the location of the recent event. The cause of these earthquakes is explained by plate tectonics [Fig. 8, following page].

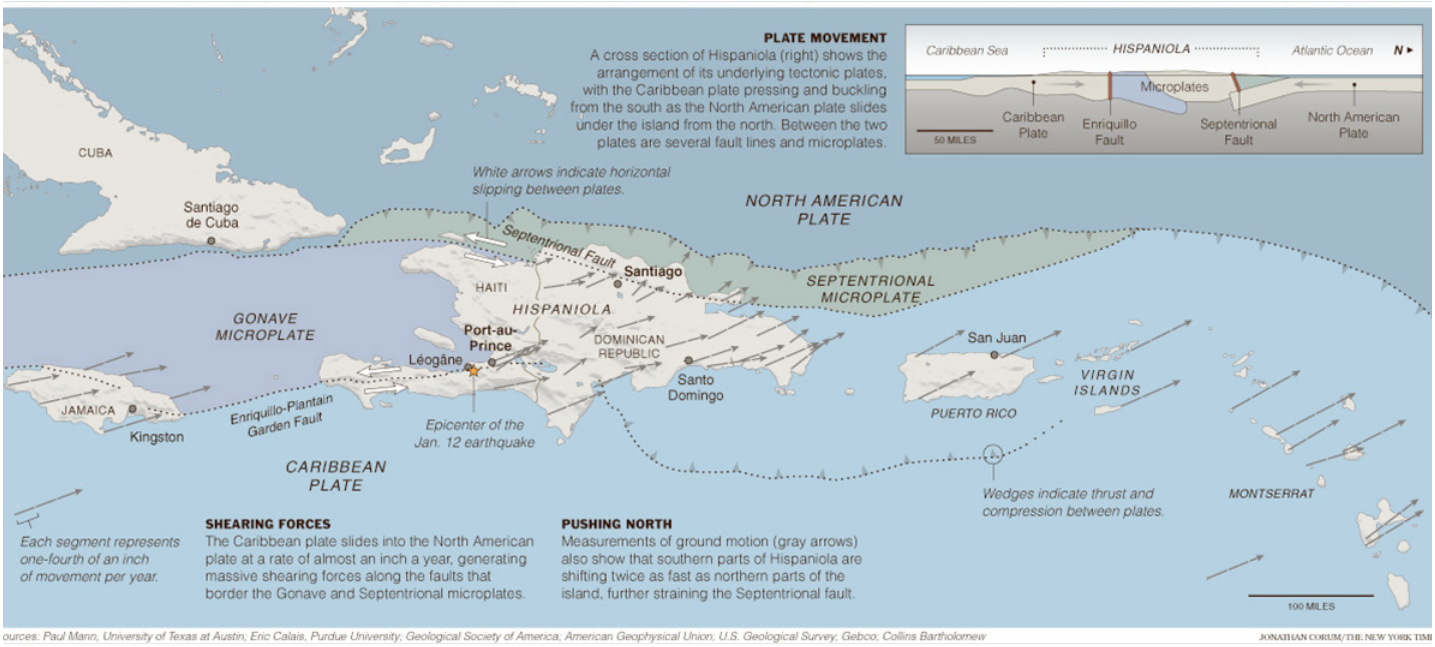

Figure 7. Map of estimated major earthquakes in the Haiti region, since the 1600s (*New York Times*, January 26, 2010)

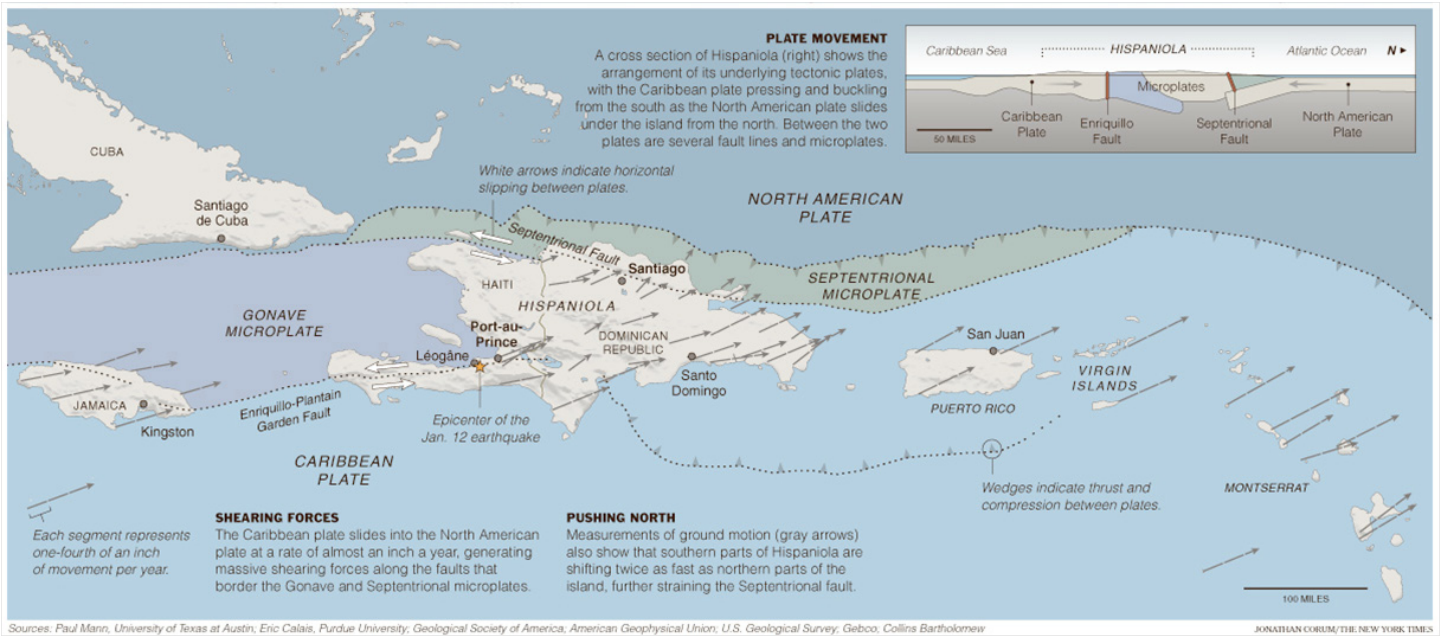

Figure 8. Plate tectonic forces in the Haiti region (*New York Times*, January 26, 2010)

To sum up: we know where and why earthquakes occur. We know why buildings collapse in earthquakes. With this knowledge, we share a responsibility to apply it, to teach it, to reach people in time. This is the responsibility of those of us who know earth science and structural engineering, .. those who should apply that science and engineering to the safe construction and siting of communities, … and those who should write and enforce good laws.

What should be done in Haiti, once the relief operations are completed?

I have four recommendations:

1. All reconstruction financed by international sources should meet life-safety standards. Informal construction, of course, cannot be controlled. Foreign-financed reconstruction should incorporate designs, materials, and methods that make the buildings earthquake- and wind-resistant. The catchphrase used to describe this goal is "Build Back Better."

I support Building Back Better, but, in my opinion, this response does not fully account for earthquake behavior: while damaging events can occur close in space and time, large earthquakes do not usually strike the same place again for a long time, sometimes centuries. Meanwhile, the average life span of most buildings is only several decades. In many locations that have suffered major earthquakes, the buildings that will be Built Back Better won't be around when the next large earthquake strikes.

Thus, it is not enough to reconstruct the recently destroyed communities. We need to use the heightened awareness of earthquake risk that was created by this recent event in Haiti to prepare those communities where the next earthquakes will occur. Unfortunately for the Haitian capital, one of those faults where future earthquakes will occur is located much closer to Port-au-Prince than was the fault that ruptured on January 12.

On this artist's rendition of Haiti [Fig. 9], looking east, the arrows show the fault on which the January 12 earthquake occurred. The slip along this fault relieved stress on this portion of the fault, but created greater stress on the portions of the fault to the east and west. This increase in stress was calculated and indicated graphically on the next slide [Fig. 10], also provided to me by the USGS.

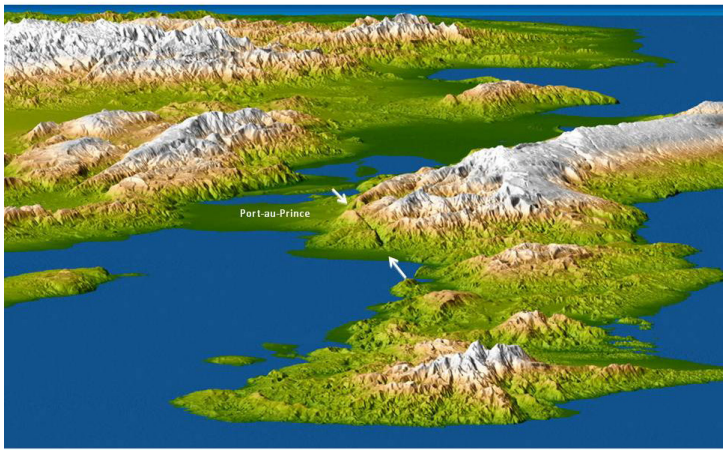

Figure 9. Artist's rendition: January 12 earthquake fault.

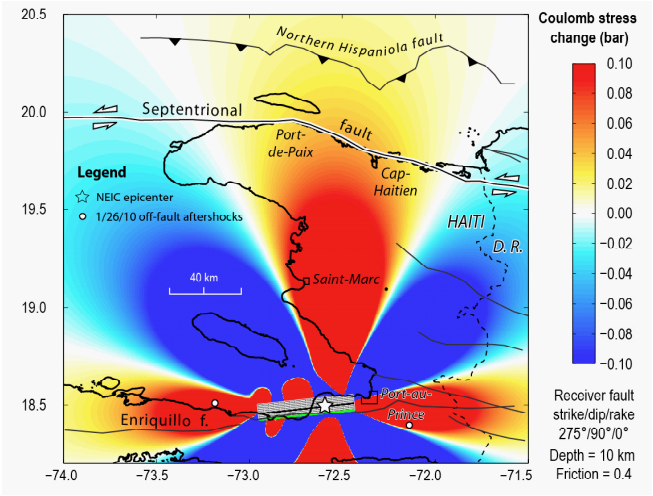

Figure 10. Coloumb Stress Figures.

Superimposed on this map of the western coast of Haiti, you can see the red zones where the stress was increased as a result of the January 12 event. The increase in stress brings the faults in these red zones closer to failure. You can also see that these zones fall in some of the areas that experienced large earthquakes in the past, including Port-au-Prince.

These maps allow you to appreciate where danger lies in the future and where preparation is needed, urgently.

Although "building back better" is not enough, on its own, we should use the opportunity to increase the capacity of local professionals. The locals can learn good design, material and construction methods. The public can understand that earthquake-resistant construction is possible, and they will learn to demand it. This coincidence of demand and supply is *essential* for safe construction to become self-sustaining and to diffuse into regions that will be struck by Haiti's next earthquakes. This is possible! GHI has had experience in projects where good construction practice has taken off and diffused throughout a society.

2. *All* future new investments in the development of Haiti—not just those for the reconstruction of buildings destroyed in the recent earthquake— must incorporate proper design and construction to achieve a life-safety standard. Development agencies such as the World Bank and USAID, which fund construction projects, must require sound design and construction in all future investments.

An additional investment of approximately 10% could have made the schools, hospitals and hotels that collapsed in Haiti earthquake-resistant.

These projects must involve local architects, engineers and masons. If internationally-funded projects use only their own people, then local capacity to build safely will not develop, and safe construction practice will not be sustained.

3. Recommendation #3 concerns the structures occupied by international agencies.

How very sad that the UN building collapsed!

Residences and offices for the staff and contractors of international development and aid organizations and of multilateral banks should be made earthquake-resistant. This recommendation is about leading by example, and putting your money where your mouth is.

If those structures are made earthquake-resistant, then employees and contractors will be safer, with greater ability to remain functional and to help the community when needed most. The buildings, remaining standing after the disasters, will demonstrate that we can plan for and mitigate against earthquakes.

I recommend that all foreign organizations, such as the UNDP, IFRC, USAID, World Bank and all foreign embassies adopt a policy similar to the State of California's policy regarding its rented and owned buildings. This policy could:

- Require that by 2015, all buildings owned or rented by these agencies and all hotels that wish to serve the personnel of these agencies must be evaluated for their seismic vulnerability
- Announce that after 2015, these agencies will only occupy buildings and their personnel will only use hotels that are earthquake-resistant.
- Announce that all vulnerability assessment and seismic retrofit work commissioned by these agen cies will involve local professionals.

Such a policy would create an economic incentive for the local economy to develop the means to provide earthquake-resistant construction.

4. My fourth and final Recommendation has to do with directing additional resources to preparedness and mitigation.

The resources made available, worldwide, for managing natural disasters in developing countries have been directed primarily toward relief and reconstruction, rather than toward mitigation and preparedness. Helping people when they are in greatest need, by providing search and rescue, relief and reconstruction is humane and necessary. But these efforts must not displace efforts to *prevent* death and losses in the future.

Imagine what our world would be like today, if resources to combat the AIDS epidemic over the past few decades had been directed primarily toward treating symptoms of that illness, rather than toward preventing AIDS.

What would preparation and mitigation work look like in Haiti? It could include activities such as training masons, raising public awareness of earthquake risk, improving engineering and earth science curricula in local schools, mapping geologic hazards, and developing effective school and hospital earthquake safety programs.

Conclusions

Much of this talk so far must sound rather bleak. We've thought about the terrible suffering in Haiti that is still continuing. I've tried to convince you that current earthquake risk reduction efforts have not yet successfully countered the effects of rapid urbanization in developing countries, and that, unless we can significantly improve those efforts, we must expect to see about 20,000 earthquake-caused deaths/year worldwide, with a likelihood of seeing one earthquake kill 1 million people in this century.

I'd like us to use the rest of this evening discussing with you proposals to make things better.

Recently I wrote an op-ed in which I attempted to make such a proposal. I suggested that the efforts to prepare Haiti for its future earthquakes should be supported by allocating some of the funds that are now being collected for the relief and recovery efforts for the recent earthquake. I've never written something that has sparked more angry responses and also more supportive responses. Some people said that the funds collected for relief and response will not be sufficient to treat all the victims, and so it is inhumane of me to propose to re-direct any them to prepare for unspecified future disasters. On the other hand, other people wrote, knowing how past efforts to raise funds for preparedness have been unsuccessful and that preparedness will save lives, to congratulate me on this innovative idea. I see both sides.

This proposal that I made may not be the solution to funding preparedness activities, but we need to find new approaches.

To return to my medical analogy, if we consider the advances that have been made in tackling AIDS and polio, in both cases, our society aided the victims of these illnesses but, at the same time, supported efforts to find and disseminate cures. In the earthquake context, I see the outpouring of aid for the victims, but not much interest in disseminating the cure. And to repeat: we have a cure; we don't need more research. The bottleneck has been getting these advances in the hands of people who need them most.

We need new tactics, maybe new language.

Psychologists tell us that, because of our evolution, we have more difficulty responding to remote, slowly increasing threats (such as climate change and rare earthquakes) than to close, quickly increasing threats (such as an advancing fire or tiger). I accept this. Yet I see that our society has, in my lifetime, rather successfully dealt with the "remote" threats of smoking and of driving without a seatbelt. I think that we earthquake mitigators have something to learn from these social movements.

What I think is needed, and what I'd like to discuss with you all at this time, is conceiving of a significantly different approach to reducing the loss of life and property to earthquakes. One "outside the box" possibility is to launch a new multi-disciplinary program to put the advances of earth science and earthquake engineering into the hands of the people who need them the most. In some cases, these people will have to be convinced that they need these advances. This program would draw on the talents of not only seismologists and engineers, but also psychologists, legislators, government regulators, sociologists, as well as people from the construction industry, Madison Avenue, Silicon Valley and Transparency International. Together, we need to devise improved, innovative ways to communicate the benefits of earthquake risk reduction to the people whose lives could be saved. To be successful, we would need to attract the support – moral as well as fiscal – of international development and aid agencies. We're talking about using preparedness and mitigation as tools to promote sustainable development.

I now am looking forward to hearing your thoughts on these ideas. Thank you for your attention.